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Not just another brick in the wall

The solutions exist. Scaling them will build on progress and cut emissions fast.

Global Alliance for Buildings and Construction

Global Status Report for
Buildings and Construction 2024/25

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Political Statement

KENYA

Hon. Alice Wahome, EGH.
Cabinet Secretary, Ministry of Lands, Public Works,
Housing & Urban Development, Kenya

As the Vice-Chair of the Intergovernmental Council for Buildings and Climate (ICBC), Kenya acknowledges the significant role played by the United Nations Environment Programme (UNEP) and the GlobalABC in promoting climate actions within the construction sector. In pursuit of this commitment, Kenya is advancing its sustainable development agenda using its New National Building Code,2024, which came into effect on 1st March 2025 and sets forth energy performance standards aimed at improving resource efficiencies and sustainability.

The Global Status Report for Buildings and Construction is instrumental in establishing quantifiable targets and providing clear pathways, thereby guiding Kenya's transformative initiatives and ensuring alignment with shared climate objectives.

GERMANY

Mr. Berthold Goeke,
Director General on Climate Action,
Federal Ministry for Economic Affairs and Climate Action, Germany

Germany proudly supports the Global Status Report for Buildings and Construction 2024/25, both technically and financially. Our aim is to leverage innovation in low-carbon materials, electrification, energy efficiency and circular construction to cut emissions and create new jobs in a just and equitable manner.

We value collaboration with all international partners, recognising that public and private investments together can transform our built environment at scale. Through shared effort, and steady progress, we will ensure the buildings sector delivers on our climate ambitions and secures a sustainable future for everyone.

FRANCE

Mr. Yves-Laurent Sapoval
Délégué ministériel pour la ville durable International -
Urban Envoy, Ministères Territoires Écologie Logement

France reaffirms its strong endorsement of the Global Status Report for Buildings and Construction 2024/25 as a vital instrument for climate action. We stand ready to collaborate with the global community to tighten building codes, cut embodied carbon, and scale up low-carbon innovations.

Our aim is to make renewable and low GHG energy accessible for all, speed up building retrofits, and ensure every home meets high standards for sustainability and resilience.

We see mobilisation of all actors for equitable, affordable green financing as essential to fostering inclusive growth, job creation and wellbeing across the sector.

Together, we are committed to meeting the Paris Agreement targets and preserving our planet for generations to come."

BRAZIL

Ambassador Antonio Da Costa e Silva,
Chief International Advisor, Ministry of Cities,
Government of Brazil

Alongside France and Kenya, Brazil is proud to serve as a vice-chair of the Intergovernmental Council for Buildings and Climate (ICBC).

We deeply value our longstanding partnership with UNEP and the GlobalABC, and we recognize the Global Status Report for Buildings and Construction (Buildings GSR) as an essential tool for transforming the buildings and construction sector.

We are committed to using its insights to implement low-carbon solutions, strengthen codes and foster equitable development across our built environment. Moreover, we believe that COP 30 will highlight how developing countries with renewable energy sources serve as important examples of low-carbon solutions, creating opportunities to reduce emissions.

As the host of COP30, we look forward to turning the report's recommendations into practical steps for a zero-emission and resilient future.

Photo: Ruhma Ukaye / Climate Visuals Countdown

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Abbreviations

BECs	Building Energy Codes
EPBD	Energy Performance of Buildings Directive
IEA	International Energy Agency
IDB	Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
GlobalABC	Global Alliance for Buildings and Construction
GBCT	Global Buildings Climate Tracker
GHG	greenhouse gas
MEPS	Minimum Energy Performance Standards
NDCs	Nationally Determined Contributions
NZE	Net Zero Emissions
UAE	United Arab Emirates
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
WorldGBC	World Green Building Council
ZEB	zero emissions building

Photo: Unsplash

Executive summary

In 2024, the Paris Agreement goals for the buildings and construction sector were out of reach

As of early 2025, the buildings and construction sector, which includes the embodied carbon of construction materials, continues to grapple with its significant contribution to global energy-related CO_2 emissions. In 2023 the sector's emissions stood at 34 per cent, while energy consumption accounted for around 34 per cent of global demand. Despite modest advancements, the sector is not yet on track to align with net zero carbon and climate resilience targets by 2050, as progress remains slow and fragmented. CO_2 emissions from the sector have risen by five per cent since 2015, far from meeting the 28 per cent reduction required by 2030 to align with the Paris Agreement.

Notable progress has been observed in specific areas in 2024. Increasing adoption of renewable energy and electrification, especially for heating and cooling systems, has been a positive trend. In addition, green building certifications grew significantly, with 20 per cent of new commercial buildings in Organization for Economic Cooperation and Development countries achieving certification in 2023, up from 15 per cent in 2020. Circular construction practices—such as material reuse and modular building—are also gaining ground, with recycled materials accounting for 18 per cent of construction inputs in Europe.

However, the sector still faces critical challenges. Embodied carbon from materials like steel and cement persists as a major source of emissions, contributing to 18 per cent of global building-related CO_2 emissions. The adoption and revision of building codes slowed dramatically, with only three updates recorded globally in 2024 compared to over 20 in 2023. Inadequate policy frameworks and a lack of detailed decarbonization roadmaps in most Nationally Determined Contributions (NDCs) remain significant barriers. Cumulative investments in energy efficiency also fall short by US$1.1 trillion, while gaps in green financing, such as concessional loans or incentives for low-carbon solutions, inhibit widespread progress.

To address these shortfalls, the 2024 Global Status Report for Buildings and Construction underscores the urgency of harmonizing building codes, scaling low-carbon materials, increasing equitable access to green financing and incentivizing circular construction. Workforce development programmes must also prioritize filling skill gaps while fostering gender diversity in green construction leadership roles. Moreover, stronger global coordination and accountability mechanisms such as the G20's Voluntary Action Plan to double energy efficiency by 2030 are critical to accelerating progress.

The lack of change in energy and related emissions shows that efforts in the buildings and construction sector remain off track

In 2023, buildings accounted for 32 per cent of global energy demand and 34 per cent of CO_2 emissions, with operational emissions reaching a record 9.8 gigatonnes, while embodied carbon was around 2.9 gigatonnes (Figure ES.1). Despite a minor reduction in embodied carbon emissions and increased adoption of renewable energy—17 per cent of total buildings energy demand by 2023—efficiency improvements remain insufficient to meet the Paris Agreement goals.

The *United Nations Environment Programme Emissions Gap Report* (2024) highlights the critical need for accelerated action in the buildings sector to meet global climate goals. To align with a 1.5°C climate pathway, the report projects that the buildings sector will account for around 11 per cent of global mitigation potential by 2035, equivalent to 4.2 $GtCO_2e$ of avoided emissions.

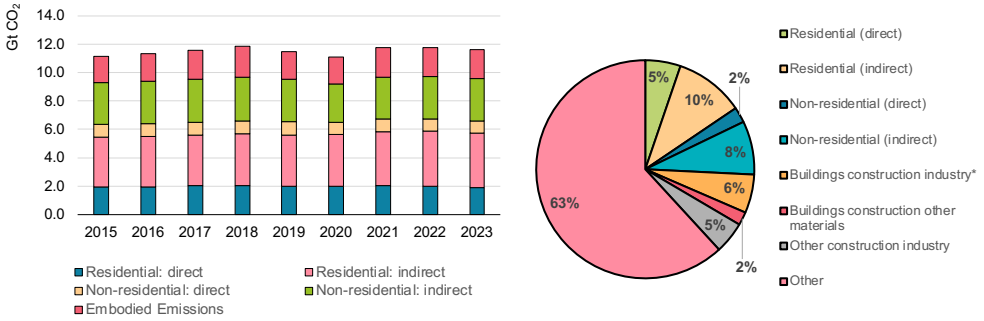

Figure ES.1. CO_2 emissions in buildings 2010–2023 (left) and share of buildings in global energy and process emissions in 2023 (right) (International Energy Agency 2024a)

*"Buildings construction industry" and "Other construction industry" refers to concrete, steel and aluminium for buildings and infrastructure construction.

Developing policy focus through concerted efforts across national and local initiatives

National policies play a pivotal role in advancing the decarbonization and sustainability of the buildings and construction sector and provide the strategic framework necessary to align long-term goals, incentivize innovation and foster sustainable practices.

Innovative national policies from countries like Germany, South Africa and Rwanda demonstrate the effectiveness of combining mandatory performance standards, economic incentives and financial mechanisms to support green construction. Germany's Federal Climate Change Act sets ambitious emission reduction targets and provides subsidies for energy-efficient retrofits, while Rwanda's cooling strategies and renewable energy incentives showcase the transformative potential of regulatory and market-based approaches. However, aligning these policies with broader climate goals, like NDCs, remains essential to ensuring that the sector meets its net zero targets by the middle of this century.

Building energy codes are among the most effective tools for curbing operational emissions. With 85 countries adopting codes for residential buildings, 80 per cent being mandatory, recent updates in Kenya, Germany and Iceland highlight the adoption of renewable integration, life cycle assessments and energy-efficient design for buildings. Yet, over 50 per cent of new global construction remains uncovered by such codes, jeopardizing climate targets and energy efficiency goals.

NDCs, which align national efforts with the Paris Agreement, reflect growing sectoral integration, with 80 per cent addressing mitigation in buildings. However, only 18 per cent have quantifiable targets, and financial pathways are inconsistent. Strengthening NDC frameworks in the NDC 3.0 process through measurable goals, embodied carbon considerations and regional equity is essential for achieving both mitigation and adaptation objectives.

Substantial effort is needed to scale deep retrofits and improve building energy codes to reduce energy intensity (currently just over 130 kWh/m²/year) and accelerate decarbonization. Circular economy practices, including extending building lifespans, reusing materials and improving recycling, offer promising opportunities to lower embodied carbon. Strategies like green leasing are driving growth in low-carbon office spaces, while policies such as Extended Producer Responsibility (EPR) enhance waste management.

Globally, the construction sector generates an estimated two billion tons of construction and demolition waste (CDW) annually, accounting for approximately one-third of all global waste. Adopting circular construction practices is essential to significantly reduce waste, conserve resources and mitigate climate and environmental impacts on a global scale. A key enabler of this transition is EPR, a policy approach designed to internalize external costs from waste management. Several countries are leading the way in implementing EPR frameworks for construction and demolition waste. France, for example, has introduced a comprehensive EPR scheme for CDW, the Netherlands has an EPR programme for flat glass, and India is actively developing its own EPR framework for the construction industry.

Global investments have fallen and risk delaying action

The global buildings sector faces mounting challenges in achieving sustainability and climate resilience amidst economic pressures. In 2023, global investment in energy efficiency for buildings fell by seven per cent to US$270 billion, driven by rising borrowing costs and the tapering of key government programmes, particularly in Europe. Despite these setbacks, innovative financing mechanisms and government initiatives have emerged. China's Incentive Fund for Green Building Development and Australia's Clean Energy Finance Corporation show how allocating significant funding to retrofit existing buildings can encourage energy-efficient and net zero construction. Programmes in South Africa, the United States of America and Germany also demonstrated the critical role of fiscal incentives in driving greener building practices.

However, the sector remains underfunded, with only four per cent of global buildings investment focused on green initiatives in 2023. Urban areas, accounting for much of the construction activity, are central to progress but require an estimated US$1 trillion annually for green retrofits and energy-efficient projects. Green bonds and sustainability-linked debt have shown resilience and growth, underscoring their pivotal role. Still, emerging markets face underdeveloped financing landscapes, though recent green bond issuances signal progress. Addressing these gaps through targeted financing, policy support and private-public collaborations will be crucial to aligning the sector with global net zero and climate goals.

The lack of progress is clear, and action is needed to overcome policy gaps

The Global Buildings Climate Tracker (GBCT) reveals the buildings sector is significantly off track to meet its 2030 and 2050 decarbonization goals. Between 2015 and 2023, CO_2 emissions from building operations increased by 5.4 per cent, contrary to the 28.1 per cent reduction required. Energy intensity declined by just 9.5 per cent, falling short of the 18.2 per cent target, while the share of renewable energy in final energy demand rose by only 4.5 percentage points, well below the 17.8 point goal. Green building certifications grew but remain 7.7 percentage points behind the benchmark, and cumulative energy efficiency investments are US$1.1 trillion below the required level.

Policy progress remains insufficient. Only 19 countries have extensive details for actions to integrate buildings sector strategies into their NDCs, and just two have implemented energy codes aligned with zero emissions building (ZEB) standards. To meet 2030 targets, annual improvement on the GBCT now needs to accelerate to 10 points—almost twice the original rate required in 2015.

As of 2023, key metrics such as energy-related emissions, energy intensity and renewable energy adoption remain well below required progress rates. Direct and indirect CO_2 emissions from building operations increased by 0.6 per cent annually from 2015 to 2023, whereas a four per cent annual reduction was needed. Achieving 2030 targets now demands an unprecedented 10.8 per cent annual decrease in emissions—more than double the original pace. Similarly, reductions in energy intensity and growth in renewable energy must accelerate by factors of three and seven, respectively.

Policy gaps and insufficient investment are critical barriers. Most regions lack ZEB codes, and few countries address the buildings sector comprehensively in their NDCs. Energy efficiency

investments must more than double to US$522.5 billion annually by 2030, while adoption of green building certifications and renewable energy systems needs rapid expansion.

Urgent, coordinated action is essential. This includes strengthening building codes, scaling up investments, expanding renewable energy integration and adopting life cycle approaches to reduce both operational and embodied emissions. The upcoming 2025 NDC 3.0 updates present a critical opportunity to embed buildings sector decarbonization into global climate strategies. To close the widening gap and achieve climate goals, immediate and decisive measures are required.

Roadmaps build coalitions and commitments for action in the buildings sector

A growing number of countries have adopted tailored roadmaps under this framework, many using the Global Alliance for Buildings and Construction methodology offering a step-by-step guide. Bangladesh targets near-zero carbon emissions in new and retrofitted buildings by 2050, while Ghana focuses on low-carbon construction materials and urban development to reduce emissions and improve resilience. Senegal emphasizes sustainable materials, solar solutions and professional capacity-building, advancing low-carbon practices by 2050. Similarly, the Arab Region Roadmap supports 22 nations with strategies for climate-responsive urbanization and renewable energy adoption, aiming for net zero emissions by 2050. Complementary frameworks, like the National Circularity Assessment, further address life cycle impacts, promoting resource efficiency and material reuse. Together, these roadmaps provide a cohesive path to decarbonization while fostering economic growth, inclusivity and climate adaptation in the built environment.

International efforts to create change in the buildings sector continue to push ahead

The Buildings Breakthrough Agenda, officially launched during COP28 in December 2023, aims to make "near-zero emission and resilient buildings the new normal by 2030." Endorsed by 45 countries representing over 70 per cent of global gross domestic product, this initiative outlines six key action areas to drive buildings sector decarbonization: (1) Standards and Certification, (2) Demand Creation, (3) Finance and Investment, (4) Research and Deployment, (5) Capacity and Skills and (6) Landscape Coordination. These key action areas guide nations on policy development, cross-sector collaboration and resource mobilization to meet shared goals. For example, the Standards and Certification priority area focuses on building consensus among countries on qualitative definitions and principles for Near-Zero Emissions and Resilient Buildings (NZERB) across the entire life cycle, and outline related indicators, as well as guidelines to help ensure transparency, comparability and accountability, while the Demand Creation priority area emphasizes procurement policies and commitments to promote low-carbon construction and renovation.

Progress on these actions remains nascent, but foundational strides—such as creating unified definitions and advancing industry standards for whole-life carbon—are gaining traction. The Chaillot Declaration, issued at the inaugural Buildings and Climate Global Forum in 2024, reinforced international commitments to decarbonization through mandatory energy codes, sustainable materials and capacity-building. Looking ahead, sustained collaboration, robust governance and implementation of agreed milestones through mechanisms like the Intergovernmental Council on Buildings and Climate are essential to accelerating the sector's net zero transition.

To intensify efforts to reduce emissions in the buildings and construction sector and strengthen commitments through international collaborations like the Buildings Breakthrough Agenda and the Chaillot Declaration, countries are taking steps in terms of mitigation, adaptation and recent efforts to support sustainability of the buildings sector.

South Africa has introduced several policies and initiatives to promote building decarbonization and energy efficiency, such as the National Building Regulations that mandate energy efficiency standards for new buildings and renovations.

Rwanda's energy efficiency policies include the incorporation of the National Cooling Strategy into building codes, implementation of minimum energy performance standards for key products, and mandatory energy audits for industries and buildings.

In March 2024, China introduced an action plan to further enhance energy conservation and carbon reduction in the construction sector, with the objective to establish a robust institutional framework by 2025 and to scale up ultra-low energy consumption buildings by 2027.

Mexico has a commitment to reduce 66 per cent of emissions of residential and commercial buildings by 2030. This has been supported by the implementation of diverse norms for energy efficiency: for electrical and thermal energy, energy efficiency in public administration and for small- and medium-sized enterprises.

Germany aims to achieve a 65 per cent reduction in CO_2 emissions from buildings against 1990 under its Federal Climate Change Act. Key mitigation measures include the Building Energy Law and Reconstruction Loan Corporation/Federal Office for Economic Affairs and Export Control subsidies for energy-efficient construction and renovations.

France introduced Environmental Regulation RE2020, which integrates life cycle carbon analysis into building design.

Tunisia aims to enhance energy efficiency and reduce emissions in the buildings sector, targeting a 45 per cent reduction in carbon intensity by 2030. Key initiatives include the Energy Transition Program for Public Buildings, deploying solar photovoltaic systems, and promoting energy efficiency under the Energy Transition Strategy.

Current United Kingdom policies for mitigating and adapting the buildings sector focus on supporting net zero carbon emissions by 2050, with a 78 per cent reduction by 2035. Key strategies include retrofitting existing buildings to improve energy efficiency, prioritizing low-carbon materials and implementing whole-life carbon assessments for construction projects.

Nigeria is advancing efforts to decarbonize its buildings sector, targeting a 43 per cent reduction in emissions by 2030 and a 97 per cent reduction by 2060 under the Renewable Energy Scenario outlined in its Long-Term Low-Emission Development Strategy (Nigeria, National Climate Change Council 2024).

Viet Nam has developed a plan to implement a roadmap for reducing greenhouse gas (GHG) emissions in the construction sector, aiming to establish a pathway for emissions reduction in urban development, building construction and building materials manufacturing. The development of the GHG reduction roadmap for the construction sector began in 2024 and is expected to be completed by 2026. GHG inventory plans for construction projects will become mandatory in 2025 for projects emitting over 3,000 tons of CO_2 equivalent.

Rising to the challenges

Despite growing awareness, the sector remains significantly off track, with limited change in energy use and inadequate policy enforcement posing major barriers to achieving zero-carbon goals. Key challenges include improving energy efficiency, integrating renewable energy, addressing embodied carbon emissions and securing necessary financing.

Challenge 1 – Building codes: Major carbon-emitting countries, including the G20 and European Union, must adopt mandatory zero-carbon building energy codes by 2028. Other countries with existing codes should upgrade to zero-carbon-ready standards and make them mandatory by 2030. Countries without codes must establish a pathway to mandatory adoption by 2035.

Challenge 2 – Retrofits: The rate of building energy efficiency retrofits should be tripled by 2030 to achieve 35 per cent reduction in energy intensity. Major emitters must upgrade passive designs and adopt high-performance systems like heat pumps. Emerging economies should target older buildings and enforce mandatory improvements through energy codes and policies.

Challenge 3 – Renewable energy adoption: The global goal of tripling renewable energy in buildings should be reflected. The deployment of renewables should be accelerated to increase the share of buildings' onsite-generated renewable energy from six per cent to 19 per cent, and the total share of electricity consumed from renewable sources (on- and offsite) should be raised from 11 per cent to 46 per cent by 2030.

Challenge 4 – NDC Integration: Major emitters and G20 governments must include detailed building code reform plans in their NDC 3.0 submissions and use Biennial Update Reports to track progress and ensure accountability.

Challenge 5 – Embodied carbon: Major emitters and G20 countries must adopt embodied carbon limits in building codes by 2030, with clear guidance on reporting. Other countries should promote low-carbon materials, prioritizing reuse and setting stretch targets aligned with regional best practices.

Challenge 6 – Financing: Global building energy efficiency investment should be doubled, from US$270 billion to US$522 billion by 2030. Major emitters should leverage public funds and incentivize private investment. All governments must ensure green financing fully accounts for carbon costs and the social value of building decarbonization.

Overcoming these challenges is crucial to closing the emissions gap and ensuring a sustainable, low-carbon future for the built environment.

While the sector has made incremental strides in integrating renewables, scaling efficiency technologies and advancing certifications, the pace of change remains insufficient. With emissions reduction targets looming, stronger policies, investments and cross-sector collaboration will be essential to unlocking the full potential of the buildings and construction sector as a key driver of sustainable global development.

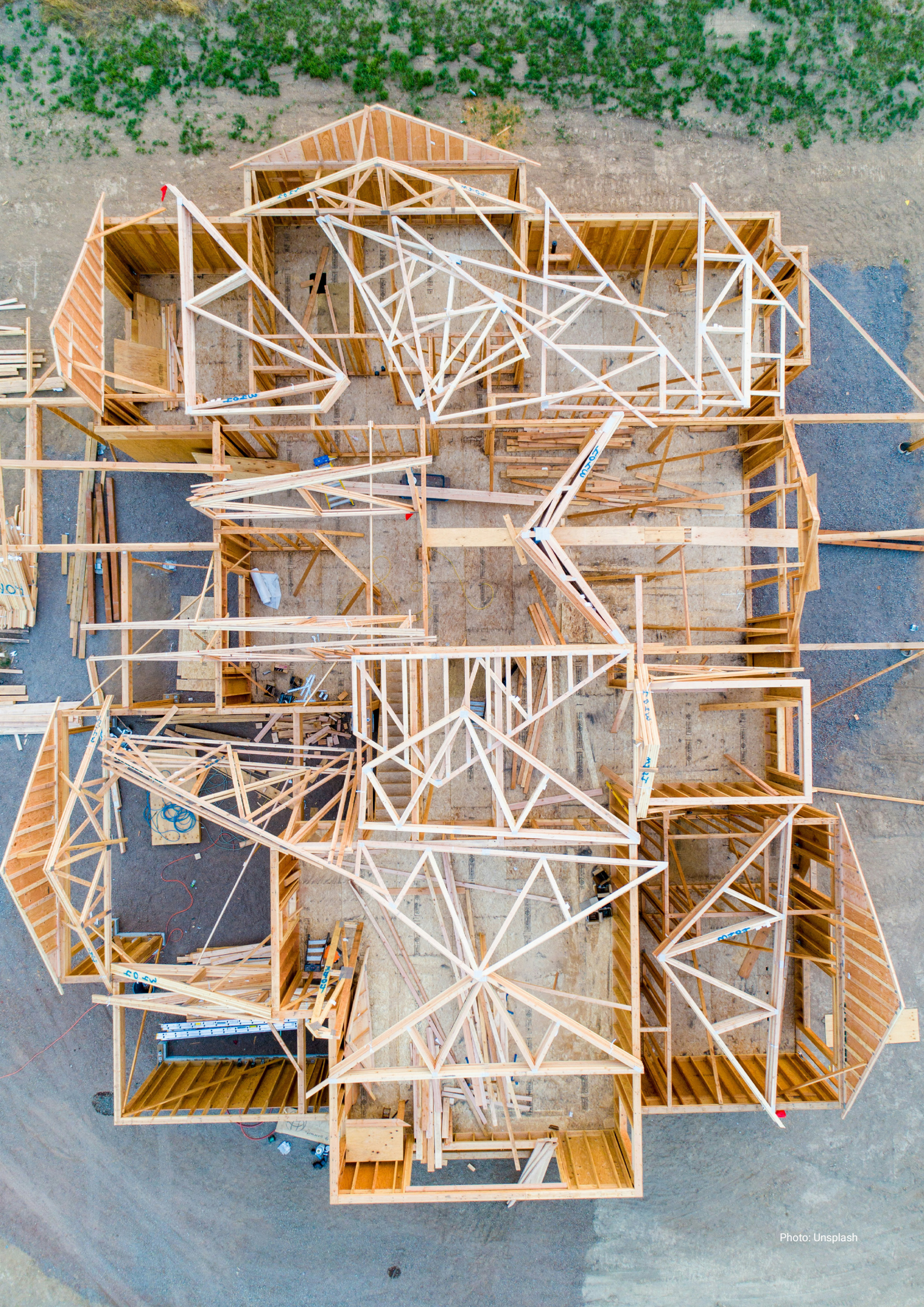

Photo: Unsplash

Chapter 1 The state of the buildings sector in 2024

The buildings and construction sector remains a critical area for achieving global net zero carbon and resilience goals, accounting for approximately 34 per cent of energy-related CO_2 emissions and over 32 per cent of energy demand in 2023 (International Energy Agency [IEA] 2024a) (see Chapter 2).

The buildings sector has made tentative, though insufficient, steps towards decarbonization, driven by greater electrification of heat supply and increased use of renewable energy sources for heating and electricity. The adoption of smart energy technologies, such as demand response systems and energy management software, also played a key role in optimizing energy consumption and reducing peak demand. Heat pump installations saw a three per cent decline compared to previous years as governments and businesses explored alternatives to fossil-fuel-based heating systems. The market for green building certifications grew significantly—over 20 per cent of new commercial buildings in Organization for Economic Cooperation and Development (OECD) countries were certified green, compared to 15 per cent in 2020. Globally, certification efforts are leading with Excellence in Design for Greater Efficiencies (EDGE), Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED), and a growing effort around regional labels. Digital technologies are playing a transformative role in driving energy efficiency, with 40 per cent of large construction firms reporting the use of Building Information Modelling in 2023 to optimize energy use during the design phase.

The adoption of circular construction and reuse of existing buildings practices has also accelerated. For example, in Europe, the use of recycled materials such as steel and cement rose to 18 per cent of total construction inputs by the start of 2024, spurred by policies embedded in the European Green Deal (European Environment Agency 2025). Globally, modular construction and material reuse continue to gain traction as strategies for reducing embodied carbon. However, addressing embodied carbon remains a pressing challenge, as cement and steel production—accounting for a significant portion of the sector's emissions—have yet to scale low-carbon alternatives. Embodied carbon accounted for around 18 per cent of global emissions related to buildings and construction in 2023.

Despite these opportunities, significant challenges remain. Regulatory fragmentation across regions slows progress, particularly in developing countries where institutional capacity to enforce codes and standards for energy efficient and resilient buildings is limited. There has been a slowdown in the adoption and revision of building codes from more than 20 in 2023 to only three in 2024, and one new adoption of a code (Kenya) overall. Further, though most Nationally Determined Contributions (NDCs) make reference to the buildings sector, few of them offer the level of detail needed to chart the pathway forward towards Paris Agreement goals, leaving considerable requirements for the NDC 3.0 process.

The sector's progress is evaluated in the Global Buildings Climate Tracker (GBCT) and shows limited progress in decarbonizing buildings, with CO_2 emissions rising by 5.4 per cent since 2015, far from the required 28 per cent reduction. Energy use intensity and renewable energy use also fall short of targets, alongside a slowing in the growth of floor area, while cumulative efficiency investments lag by US$1,123 billion. Policy measures remain inadequate, with only 19 nations integrating detailed buildings-related measures into NDCs. Closing the growing gap between current and target emissions requires annual decarbonization gains of 10 points, strengthened reporting mechanisms and accelerated implementation of impactful measures

to align with 2030 and 2050 targets.ions requires annual decarbonization gains of 10 points, strengthened reporting mechanisms and accelerated implementation of impactful measures to align with 2030 and 2050 targets.

To accelerate progress, it is essential to strengthen local standards and regionally harmonize building codes and energy and emission performance requirements. Expanding equitable and gender-inclusive access to green financing, such as green bonds and concessional loans, will enable more widespread adoption of sustainable design and operation practices, along with renewables and digital systems. Promoting gender equity in these efforts ensures diverse perspectives and inclusive solutions, fostering innovation and creating more sustainable and equitable urban environments. Increased investment in research and development is crucial for scaling low-carbon materials and advanced construction technologies. In addition, workforce development programmes must address the skills and gender gaps, equipping professionals with the expertise needed for green construction. Such efforts can support bringing more diverse participation in the workforce, including encouraging women's participation in training and leadership roles. Lastly, incentivizing circular construction practices, including material and building reuse and waste reduction, will reduce the sector's embodied carbon footprint (France, Institut Français pour la Performance du Bâtiment [IFPEB] *et al.* 2024).

The transition toward a resilient, efficient and zero-carbon buildings and construction sector is underway but sluggish, with some small encouragement in 2023 and 2024. However, significant gaps remain in achieving global climate emission reduction and climate resilience targets. A coordinated effort among policymakers, industry stakeholders and financial institutions is needed to meet the challenges and unlock the sector's full potential. By leveraging innovation, harmonizing regulations and fostering collaboration, the sector can play a central role in shaping a sustainable future.

The G20's statement for the Voluntary Action Plan on Doubling Energy Efficiency by 2030 underscores the critical role of sustainable finance in achieving global decarbonization goals (G20 Presidency 2023), particularly through investments in energy-efficient buildings. It emphasizes the disproportionate allocation of resources to minimally efficient 'green' buildings under current sustainable finance frameworks, which risks undermining broader climate objectives.

While progress has been made, including modest increases in the energy performance strength of building codes, growth in renewable energy use and storage in buildings, and a growing adoption of sustainable building certification, challenges such as high costs, lack of detailed building decarbonization policies, limited increased in the adoption and coverage of building codes, and a lack of investment and financing continue to impede the sector's full transition. As a result, in 2024, the lack of progress means the Marrakesh Partnership global goal of net zero carbon new buildings by 2030 and all buildings by 2050 remains out of reach.

Photo: Unsplash

Chapter 2 Global buildings and construction status

2.1 Building construction trends

Between 2022 and 2023, global floorspace is estimated to have increased by five billion square metres, or a two per cent increase in the total construction of buildings, to over 260 billion square metres (see Figure 1) (IEA 2024a). This increase is less than the pre-pandemic change and reflects a continued slowing of the growth in global buildings construction from an annual growth of 2.4 per cent from 2010 to 2020, to a growth of 2.2 per cent from 2020–2023. Of the nearly 51 billion square metres of floorspace constructed in emerging and developing economies, the International Energy Agency (IEA) estimates that more than half are constructed without any applicable building energy codes (IEA 2024a).

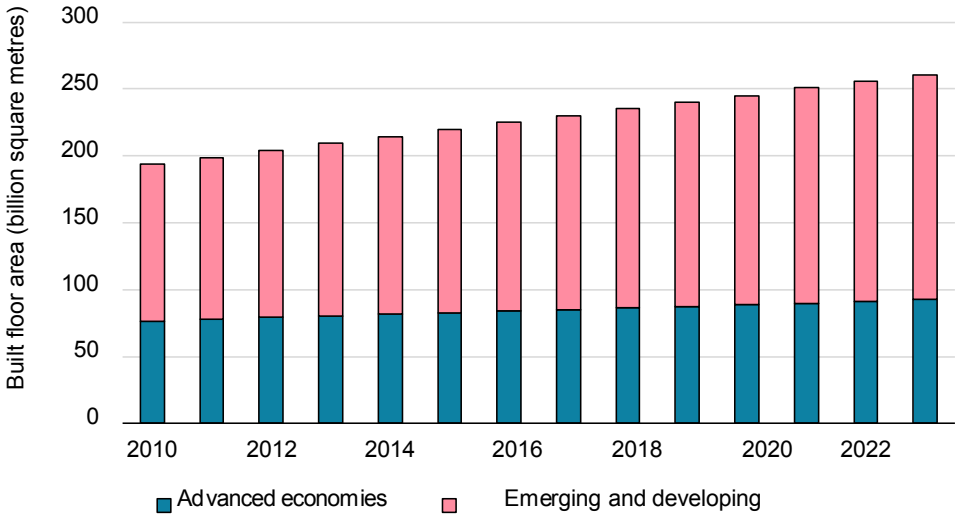

Figure 1. Global building floor area constructed in advanced, emerging and developing economies from 2010 to 2023 (IEA 2024a).

Though the growth in building floorspace varies across the world in major economies, the global production output (economic activity) associated with overall construction has seen little change (see Figure 2). Major emerging economies such as China, Brazil and Mexico have seen drops in economic production in construction, while the United States of America, Germany and Italy have seen this part of the economy continue to grow relative to 2015 (OECD 2024a).

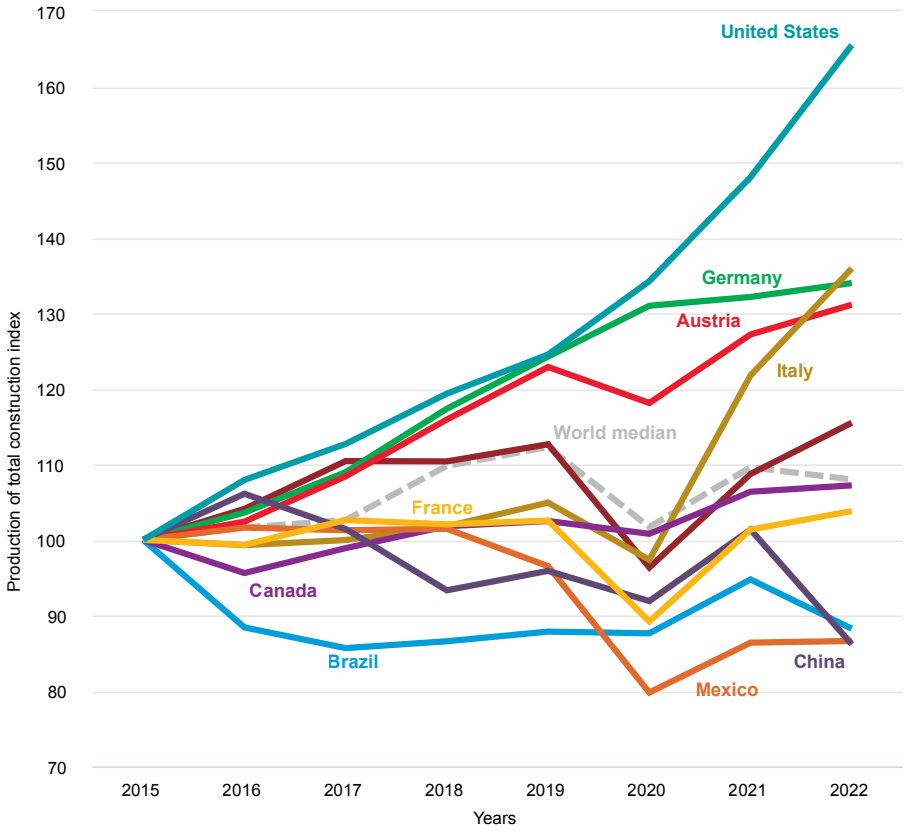

Figure 2. Production output of construction activities in select Organization for Economic Cooperation and Development countries 2015 to 2023 (OECD 2024a)

The construction of buildings is affected by the economics of borrowing, costs associated with land value and the cost of construction due to materials and labour. Through the period of the 2020–2022 global pandemic, many costs increased due to material and labour shortages and workplace and travel restrictions. The rise in prices and their inflationary effects saw central banks rapidly increase their lending interest rates to levels not seen since the mid 1990s (see Figure 3). It is estimated that the output of construction and building materials has fallen by 10 per cent since interest rates were increased (Palesch 2024).

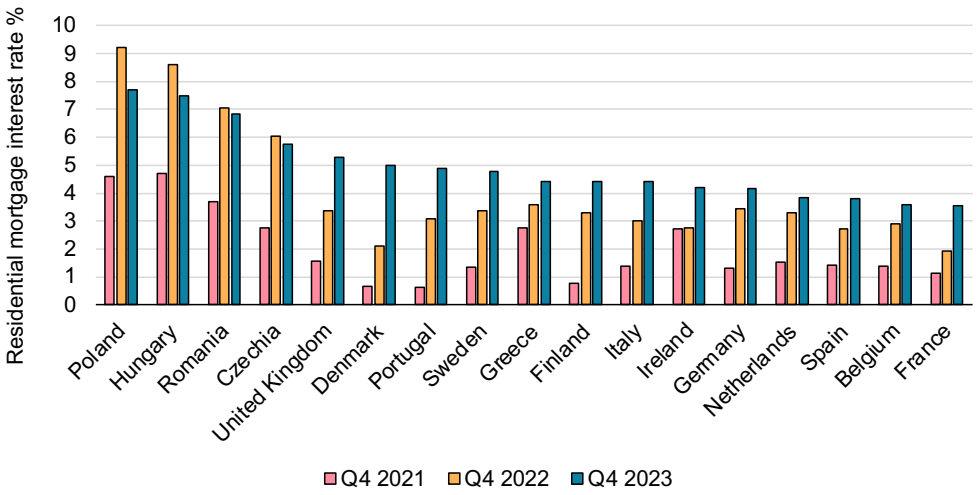

Figure 3. Average mortgage interest rates in Europe from 2021–2023 (European Mortgage Federation 2024)

Construction cost inflation remains a significant concern globally, with notable variations across regions in 2023. According to recent analysis, Africa has the highest construction cost

inflation, recording an average increase of 6.6 per cent, driven primarily by high import prices, elevated global inflation and currency fluctuations (Turner & Townsend 2024). North America follows closely, with construction costs rising by 6.1 per cent, marking higher-than-usual levels of inflation. In contrast, Europe experienced a more modest inflation rate of 2.8 per cent, while the United Kingdom reported a slightly lower figure of 4.2 per cent, below the global median (see Figure 4) (Bank for International Settlements 2024).

Despite regional disparities, there are early signs of a slowdown in construction cost inflation globally (Turner & Townsend 2024). Estimates for 2024 suggest a decline in the average inflation rate to 3.3 per cent, indicating a broad-based easing compared to the previous year. However, higher rates are expected to persist in Africa (5.7 per cent), the Middle East (4.0 per cent) and South America and Asia at 3.9 per cent, while Europe construction cost inflation averages around 1.5 per cent. The impact as interest rates rise and fall is a lag in the impact on property prices, which have shown a similar trend and have the implication of affecting overall demand and ability to invest in decarbonizing buildings.

Looking ahead, construction cost inflation may not decline as quickly as general inflation. The demand-driven nature of construction combined with a slow build of project pipelines and heightened competition among contractors and lack of skilled workers is likely to sustain price pressures (Deloitte 2024; Royal Institution of Chartered Surveyors [RICS] 2024). Globally, 54 per cent of construction company respondents surveyed cited insufficient demand as a limited factor to construction activity (RICS 2024). As a result, global construction costs are expected to rise by 3.4 per cent in 2025, offering little relief from inflationary trends (Turner & Townsend 2024).

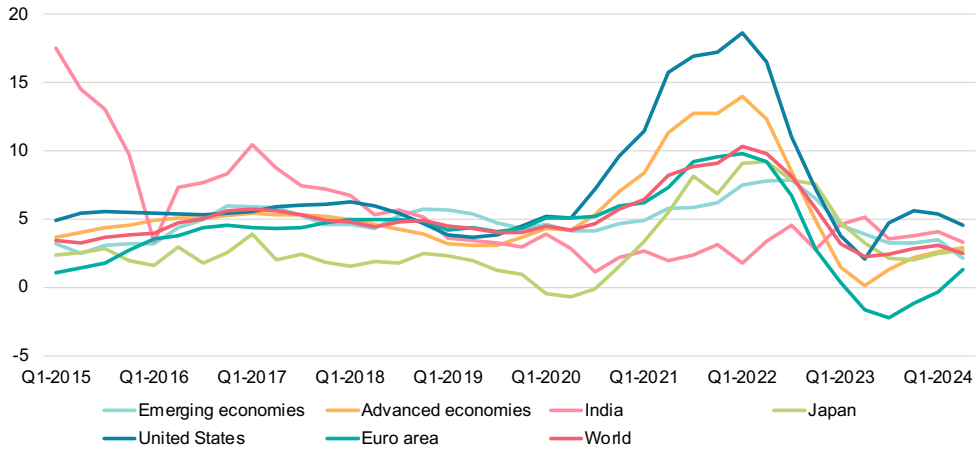

Figure 4. Comparative view of advanced economies – Select residential property prices, nominal, year-on-year changes (Bank for International Settlements 2024)

As construction activities continue to be a major source of emissions, the real estate sector plays a pivotal role in addressing carbon emissions, with significant opportunities for impact across the building life cycle. Green leasing is emerging as an important strategy in the transition to sustainable buildings, aligning tenant and landlord interests to achieve decarbonization goals.

Recent trends show a growth in demand in several major OECD economies (e.g. the United States of America, Australia and France) for low-carbon office spaces being driven by corporate commitments to carbon reduction, with over 7,600 companies signing onto Science Based Targets (JLL 2024). This shift is particularly pronounced in industries like finance, technology and professional services. Green leases incorporate performance-based criteria such as energy efficiency, electrification and renewable energy use, enabling tenants to align their space with sustainability commitments (JLL 2024).

To enhance the adoption of green leasing, collaboration between landlords and tenants is essential for integrating sustainability goals into leasing agreements. Green leases, which include specific carbon performance criteria, offer a framework to align tenant and landlord

efforts. City efforts, such as New York's Local Law 97 and France's Décret Tertiaire, are increasingly influencing leasing markets, emphasizing emissions reductions and operational transparency. Local Law 97 sets carbon caps on properties with over 25,000 square feet, with those limits being used to drive efforts to decarbonize more than 50,000 properties across the city, and a goal to reduce emissions from those buildings by 40 per cent by 2030 and to net zero by 2050 (New York City 2024).

To address gaps within the real estate leasing sector, fostering collaboration between landlords and tenants for retrofits, integrating sustainability into leasing decisions and leveraging innovative tools like green leases and performance-based frameworks will better support sustainable building demand (Green Building Alliance 2024). Aligning lease agreements with decarbonization targets can catalyse market shifts, benefiting occupiers and investors while contributing to global carbon neutrality efforts.

2.2 Energy trends in the buildings and construction sector

In 2023, the buildings and construction sector accounted for 32 per cent of global energy demand, underscoring the importance of improving energy efficiency to achieve Sustainable Development Goal 7 and meet the targets set by the Paris Agreement.

In 2023, global energy demand in buildings decreased slightly, falling to 124 exajoules per year—approximately 0.7 per cent lower than the previous year (IEA 2024a). This marks a reversal from a decade of consistent annual growth, which had averaged over one per cent. The primary factor behind this reduction was milder global winter temperatures, which resulted in decreased space heating needs, offsetting increased demand from other end-uses.

This decrease comes despite continued growth in building construction and limited improvement in the energy efficiency of buildings. The global end use energy demand intensity of the buildings sector remained little changed at just over 130 kilowatt-hours per square metre per year (kWh/m²/year) (IEA 2024a), which indicates limited progress in efficiency improvements through code adoption and minimum performance standards.

Fossil fuel use in buildings saw a significant decline in 2023 (IEA 2024a). Natural gas consumption dropped by over four per cent, continuing a downward trend that began in 2022 following the geopolitical impacts of the war in Ukraine. Conversely, electricity usage continued its upward trajectory, comprising 37 per cent of the total energy demand in buildings by 2023, up from 31 per cent in 2010 (IEA 2024a). The growing reliance on electricity was driven largely by the increased use of household appliances and air conditioners.

The uptake of renewable energy in buildings has reached unprecedented levels, driven in part by growth in Africa, with significant investments in solar, wind and other renewable technologies due to renewable generation financing (IEA 2024a). In 2023, 17 per cent of the total energy demand in the buildings sector was met by renewable sources, including both direct use of building-linked renewables and contributions from the increasing share of renewables in the power sector (see Figure 5). The IEA estimates that the installed capacity of photovoltaics (PVs) in the residential and commercial sector was around 500 GW in 2022 and increased by over 27 per cent to 628 GW in 2023, and is further estimated to grow by more than 20 per cent in 2024 (IEA 2024b). However, zero-carbon-ready technologies such as heat pumps, which play a pivotal role in enabling net-zero-ready buildings, offering an ability to decarbonize alongside the electricity grid and which operate more effectively in an energy-efficient building (IEA 2024d), have shown a slowdown in installation in 2023 related to higher costs and financing and limited installer supply chains (IEA 2024c). Recent analysis shows that around 30 countries have explicit policies that support renewable energy requirements for the buildings sector (REN21 2024a).

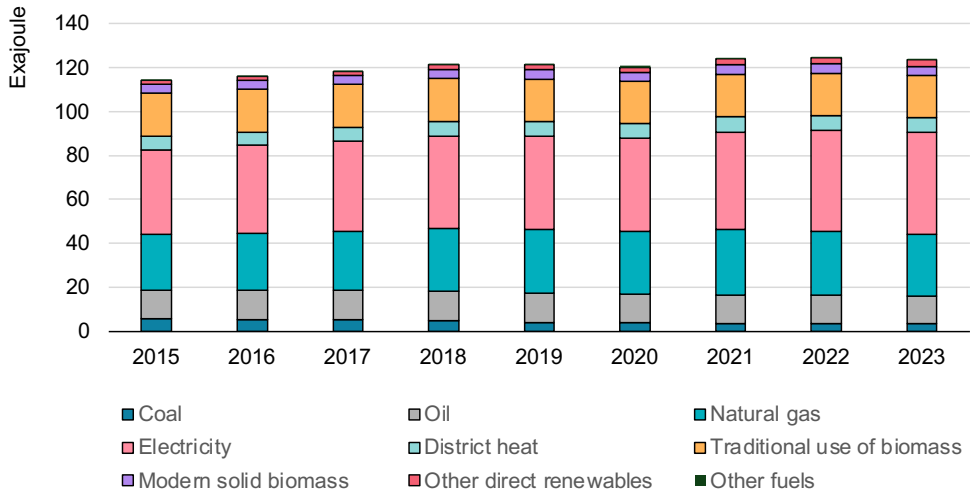

Figure 5. Energy consumption in buildings by fuel 2010–2023 (Source: IEA 2024a)

2.2.1 Regional energy demand

Energy demand trends in the buildings sector vary between advanced economies and emerging markets, with Africa and Asia and the Pacific showing the fastest growth since 2020 (see Figure 6). In advanced economies, energy demand is expected to stabilize until 2030, after which a gradual decline of approximately 0.3 per cent annually is projected through to 2050 (IEA 2024a). This decrease reflects a combination of energy efficiency measures and decarbonization efforts. In contrast, energy demand in emerging markets and developing economies is anticipated to grow. An average annual increase of 1.5 per cent is expected until 2030, followed by a moderated growth rate of 1.3 per cent per year until 2050 (IEA 2024a). This growth will be driven by rising incomes, population expansion and increased urbanization, leading to higher energy consumption.

The growing need for cooling in hot and humid climates poses a substantial challenge to energy systems, emphasizing the necessity for efficient cooling technologies and sustainable passive cooling and ventilation building designs to mitigate the rising energy burden. Cooling remains the fastest-growing end-use in the buildings sector, particularly driven by the Asia-Pacific region, having increased at an average rate of four per cent per year since 2000 (IEA 2023a).

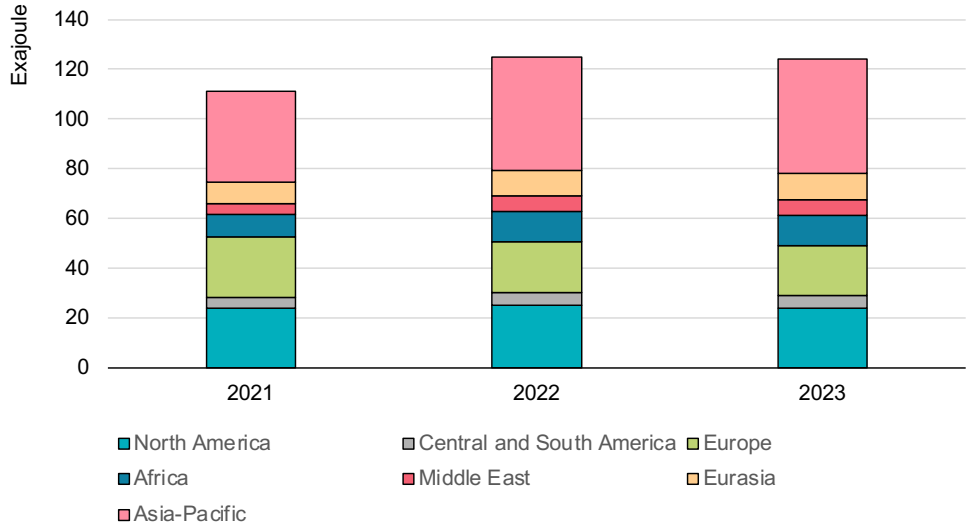

Figure 6. Energy consumption in buildings by region (IEA 2024a)

2.2.2 Supporting equity through scaling deep retrofits and energy-efficient buildings

Retrofits, and those that seek high levels of energy performance, are pivotal for reducing emissions in the buildings sector, which is a major source of global energy consumption and CO_2 emissions. By incorporating energy efficiencies and passive design; improving insulation and ventilation performance; and utilizing high-performance heating, ventilation and air conditioning (HVAC) systems and renewable energy, deep retrofits help move towards net zero targets and support a resilient, energy-efficient built environment. These measures address substantial inefficiencies, offering a key solution for decarbonization across regions. Additionally, they offer the opportunity to positively impact occupant health and capitalize on cultural and heritage value inherent within the existing built environment.

In the United States of America, for example, the state of Massachusetts illustrates how equitable retrofits can be scaled with greater effect. The 1,000 Apartment Challenge aggregates demand for retrofits in affordable multifamily housing, lowering costs, streamlining financing and deploying efficient decarbonization solutions. This initiative has demonstrated significant energy savings, with reductions of up to 87 per cent, while also improving tenant comfort and indoor air quality (Rocky Mountain Institute 2024). By emphasizing a whole-building approach, the focus shifts to integrated upgrades, such as enhanced insulation and advanced mechanical systems, which improve resilience and address longstanding disparities in housing quality.

In the Netherlands, the Energiesprong initiative has transformed over 5,000 social housing units into net zero energy homes by installing prefabricated façades and integrated energy systems, significantly reducing energy costs for residents (Interreg 2023). In the United Kingdom, the Destination Zero project led by Nottingham City Homes and Nottingham City Council employs whole-house retrofits to enhance energy efficiency in social housing, aiming to meet 2050 energy standards and improve living conditions for low-income tenants (Energiesprong UK 2023). In Mexico, the German International Cooperation Society (GIZ) retrofitted 30 social housing units in Mexicali and Hermosillo between 2019 and 2023, utilizing the EnerPHit methodology to enhance energy efficiency in challenging climates (German International Cooperation Society 2024). In Chile, the first residential passive house was certified for an energy-efficient social housing project in 2024, marking a significant advancement within the region (PassiveHouse 2024).

To scale deep retrofits, governments need clear national policies and standards targeting significant energy demand reductions, coupled with well-designed and context-based financial support mechanisms, particularly for low-income and female-led and other vulnerable households. Workforce training programmes are crucial to address labour and skill shortages, and expanding one-stop-shop services can streamline processes for building owners and educate building users.

Gender equity is a further critical opportunity to be enacted through the decarbonization agenda by supporting women to access training and skills development, higher paying jobs and leadership roles and enabling decision-making opportunities in the energy transition. Realizing action in these efforts will take specific targets and measures to track progress. Efforts focused on gender equity are being seen across the world. For example, in Kenya, the Buildher programme addresses the underrepresentation of women in the construction sector, where they make up only three per cent of professionals. By aiming to increase this figure to 10 per cent within five years, the initiative empowers women from marginalized communities with training that leads to equal pay and quality jobs (Buildher 2024). Of the 169 women trained, 80 per cent are now employed in skilled occupations, addressing labour shortages and promoting economic mobility. In India, the Mahila Housing Sewa Trust empowers women from rural and low-income households by training them as energy auditors (Mahila Housing Trust 2024). These auditors help households in informal settlements reduce energy costs and improve efficiency by adopting energy-efficient lighting and appliances, thus equipping women with valuable skills while promoting sustainable energy practices at the community level.

In the United States of America, BlocPower's Civilian Climate Corps trains low-income and formerly incarcerated individuals in New York City in building electrification (BlocPower 2024). Since its launch in 2021, over 1,700 participants have been trained, creating pathways for economic empowerment and advancing sustainable building practices. The programme offers technical training and certificates in building trades (e.g. HVAC, electrical work, carpentry) and workplace readiness training. In Akwesasne, Canada, the Mohawk Council's investment in training community-

based contractors to build energy-efficient homes has reduced residents' energy bills by over 60 per cent. By fostering local skill development and accelerating construction processes, this initiative inspires sustainable living practices within the community (ICE Network 2024).

Key actions include prioritizing affordable housing retrofits, expanding financial incentives tailored for low-income communities and minimizing tenant disruption to prevent displacement. The Affordable Housing Retrofit Accelerator in Washington, D.C., provides technical assistance, funding and no-cost energy audits to help affordable housing properties achieve compliance with the District's Building Energy Performance Standards (District of Columbia Sustainable Energy Utility 2024). The programme supports building owners in achieving up to 40 per cent energy savings while reducing carbon emissions, improving resident comfort and preparing for climate resilience. Supporting local workforce development through targeted training programmes is crucial to ensure community involvement and job creation. Standardizing retrofit processes across similar building types further reduces costs and increases project efficiency, while retrofitting heritage structures can provide a testbed for harder to abate structures and assemblies while learning from traditional knowledge.

This equity-driven approach provides a scalable model for deep energy and resilience retrofits, ensuring that all communities, particularly vulnerable populations, benefit from cleaner, healthier and more resilient buildings, while advancing broader climate and sustainability goals.

BOX 1. TOPIC SNAPSHOT: TOWARDS A PSYCHOLOGY OF SUSTAINABLE BUILDING OPERATION

The behavioural choices of building occupants significantly influence operational energy consumption and associated carbon emissions. However, the extent to which building design itself shapes occupant behaviours that are operationally relevant remains insufficiently understood (Delzendeh *et al.* 2017; Sun and Hong 2017). The evaluation of energy demand and use in buildings has become increasingly acute due to growing scientific and political pressure around the world in response to climate change. The estimation of the use of energy in buildings is therefore a critical process during the design stage. Recent research has examined how spatial parameters, lighting, biophilia and other design elements affect wellness, productivity, alertness and creativity (Yin *et al.* 2018). Despite this progress, knowledge gaps persist on how building interiors influence the behavioural decisions of occupants who spend the majority of their time within these spaces.

A critical question to arise is how building design can encourage occupants to make more sustainable choices in areas such as lighting use, stair versus elevator selection or indoor temperature settings (Moloughney *et al.* 2019). The existing literature highlights the role of explicit cues such as signage in promoting energy-efficient behaviours. For example, communicating operational energy usage data has been shown to reduce energy consumption. In contrast, implicit design features—such as spatial proportions, colours or surface materials—exert influence largely at an unconscious level (Hidayetoglu *et al.* 2012; Etzi and Gallace 2016)2016; Hidayetoglu *et al.*, 2012.

Recent research underscores the potential for material choices in interior design to indirectly influence operational energy consumption (Guida *et al.* 2024). For example, material characteristics can alter occupants' subjective perceptions of thermal comfort. Materials such as wood are often perceived as "warm", while concrete is commonly associated with "cold" sensations (Wastiels *et al.* 2012). These subjective perceptions can affect thermal tolerance. During colder seasons, interiors featuring materials perceived as "warm" may increase tolerance for cooler indoor temperatures. This effect parallels the hue-heat hypothesis in colour perception (d'Ambrosio Alfano *et al.* 2019). Although behavioural research aimed at developing design guidelines for sustainable occupant choices is still in its early stages, emerging evidence suggests that building design can proactively shape behavioural outcomes. By leveraging both explicit and implicit design strategies, architects and planners have the opportunity to create built environments that nudge occupants toward more sustainable behaviours while enhancing comfort and well-being.

BOX 2. TOPIC SNAPSHOT: HEALTH CO-BENEFITS OF ENERGY UPGRADES IN BUILDINGS

Energy-related building upgrades improve both planetary and human health by enhancing air quality and thermal resilience.

Air quality

Burning fossil fuels for heating, cooling and powering buildings generates CO_2, SO_2, NOx and particulate matter. Efficiency upgrades and electrification (e.g. replacing combustion systems with heat pumps in cleaner grids) can reduce these emissions, improving outdoor air quality and public health. MacNaughton *et al.* (2018) quantified the health co-benefits of energy-efficient, green-certified buildings in six countries, highlighting reduced premature deaths, respiratory issues and productivity losses.

Indoor air quality impacts are more complex. While reducing on-site combustion lowers pollutants, efficiency measures like decreasing outdoor air exchange can worsen indoor air quality by accumulating pollutants, pathogens or mould. Strategies like air filtration, energy recovery ventilation and efficient comfort solutions (e.g. fans instead of mechanical cooling) can mitigate these risks or avoid the energy penalties of outdoor air exchange. Gillingham *et al.* (2021) modelled both indoor and outdoor air quality and health impacts. They found that intensive building energy upgrades would have a net benefit in the United States of America, preventing premature deaths, with enhanced indoor air quality saving even more lives (Gillingham *et al.* 2021). Similarly, Maidment *et al.* (2014) analysed 36 studies with over 33,000 participants and found overall health benefits, particularly for low-income occupants.

Thermal resilience

As cities face record-breaking heat and destabilizing climate patterns, designing buildings to protect against thermal extremes is crucial. Fortunately, many energy-related building upgrades also enhance thermal resilience, both outdoors and indoors. Measures like cool roofs mitigate the urban heat island effect and reduce cooling energy use. Macintyre and Heaviside (2019) found that increasing rooftop reflectivity could reduce heat-related mortality during heatwaves due to the urban heat island effect by 25 per cent. Beyond reflective surfaces, Baniassadi *et al.* (2022) showed that energy efficiency upgrades such as roof insulation and improved cooling systems can lower outdoor heat exposure by reducing heat rejection into urban areas.

Indoors, energy upgrades like window shading and better-insulated envelopes improve passive survivability—a building's ability to maintain safe temperatures during power outages or when heating and cooling are unaffordable. Samuelson *et al.* (2016) analysed over 90,000 high-rise residential building designs and found significant overlap between energy-efficient and passively survivable features.

These studies demonstrate how energy-related building upgrades offer solutions for both climate mitigation and health adaptation.

2.3 Emissions trends in the buildings and construction sector

In 2023, the construction and operation of buildings continued to be a major source of global CO_2 emissions, accounting for 34 per cent of total emissions, making it the sector with the highest contribution (IEA 2024a). Figure 7 shows that emissions from building energy-related operations amounts to around 26 per cent from building operations, 5 per cent from (cement, steel and aluminium) and a further ~3 per cent related to glass and bricks used in construction. Operational carbon emissions from buildings reached a record high of approximately 9.8 gigatonnes of CO_2 ($GtCO_2$), remaining. In contrast, embodied carbon emissions in the construction sector showed a slight decline in 2023, falling by 2.5 per cent to approximately 2.9 $GtCO_2$. This overall stagnation in emissions reductions underscores the persistent challenge of reducing energy demand in building operations, despite ongoing efficiency efforts and the increased deployment of renewable energy.

The United Nations Environment Programme (UNEP) *Emissions Gap Report* (2024a) highlights the critical need for accelerated action in the buildings sector to meet global climate goals. To align with a 1.5°C climate pathway, the report projects that the buildings sector accounts for

around 11 per cent of global mitigation potential by 2035, equivalent to 4.2 $GtCO_2e$ of avoided emissions. Achieving this would require a significant increase in retrofit rates to improve energy efficiency, from the current global rate of less than one per cent per year to between 2.5 per cent and 3.5 per cent annually (IEA 2021).

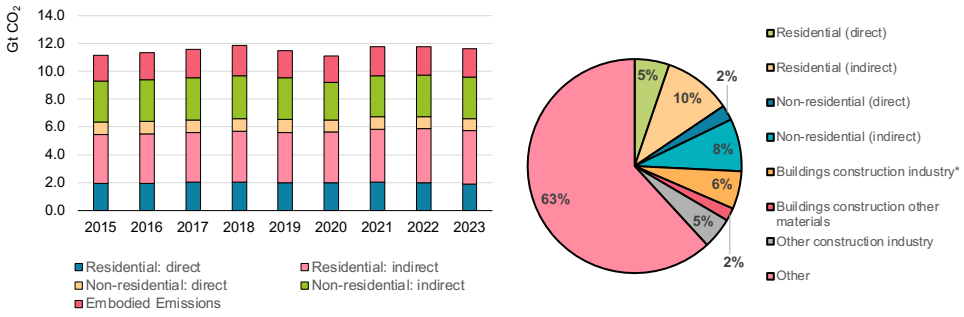

Figure 7. CO_2 emissions in buildings 2010–2023 (left) and share of buildings in global energy and process emissions in 2023 (right) (IEA 2024a)

Notes: "Buildings construction industry" and "Other construction industry" refers to concrete, steel and aluminium for buildings and infrastructure construction. The boundaries of the emissions (energy and process) account for construction materials including from raw materials preparation and processing and the different steps to produce the materials. For example, for cement this includes the entire manufacturing process, from obtaining raw materials and preparing the fuel through to grinding and milling. The numbers in the pie chart are rounded values and therefore do not necessarily sum to the total value for a given sector.

The reduction in embodied carbon indicates some progress in decarbonizing the production of construction materials, driven by slowing construction alongside improvements in supply chain practices and the adoption of lower-carbon alternatives in building materials. For example, European countries such as Germany, France and the Netherlands have increasingly utilized low-carbon cement, recycled steel and sustainably sourced timber, contributing to the regional decline in embodied carbon emissions (Research and Markets 2024). In North America, particularly the United States of America, initiatives like the Federal-State Buy Clean Initiative comprise 13 states that have committed to prioritizing efforts that support the procurement of lower-carbon construction materials in state-funded projects. The initiative has spurred the adoption of low-carbon materials by prioritizing their use in state-funded projects (United States, The White House 2023).

2.4 Circular economy and embodied carbon efforts in buildings and construction

The construction sector can enhance the circular economy by adopting practices that minimize resource use and reduce embedded greenhouse gas (GHG) emissions (United Nations Environment Programme [UNEP] and Yale Center for Ecosystems + Architecture 2023). Key actions include extending the lifespan of existing buildings through durable and adaptable design, flexibility of usage and maintenance, increasing the intensity of building use to reduce the need for new construction, and prioritizing high-quality recycling of materials to reduce reliance on virgin resources (IFPEB *et al.* 2024). Incorporating bio-based and renewable materials, designing for disassembly to enable reuse, and implementing waste reduction strategies during construction and renovation further support circularity.

Opportunities for circular economy interventions in the construction sector include enhancing material efficiency, promoting sustainable passive design for longevity, and improving waste management practices (UNEP, United Nations Development Programme and United Nations Framework Convention on Climate Change 2023). Substituting carbon-intensive materials like cement and steel with low-carbon alternatives, such as wood-based materials, offers a viable approach to reduce emissions. These substitutions should be evaluated using economic, social and environmental life cycle assessments (LCAs) to ensure their overall sustainability and emissions reduction potential. Adopting design principles that emphasize reuse, modularity and durability can extend the lifespan of materials and enable efficient disassembly for recycling or repurposing, such as the efforts in the European Union that promote principles of circularity (European Commission 2020).

Countries across the world are embedding circularity in building construction and the built environment through various innovative and policy-driven approaches (European Environment Agency 2024). The European Union's Renovation Wave initiative aims to double building renovation rates by 2030, prioritizing energy efficiency and recyclable materials, while its Construction Products Regulation mandates the use of low-impact, recyclable materials (European Commission 2024). The 2024 London Circular Economy Statement Guidance prioritizes retention, refurbishment and deconstruction over demolition. Nigeria's Circular Economy Roadmap targets construction, waste management and other key sectors, aiming to transform them from linear to circular by 2050. A variety of United States of America programmes in California; Portland, Oregon and Washington state have all promoted circularity in their building regulations and codes. These programmes will further support country-level actions to embrace low-carbon materials and circularity.

A further example of these efforts is found in the Danish Building Regulations, updated in 2023, to mandate LCAs for all new buildings and set a Scope 1–3 GHG emissions threshold of 12 kg CO_2e/m^2/year over the building's lifetime for buildings larger than 1,000 m^2 (Construction21 2024). Another is found in Australia, where the industry is making strides in addressing embodied carbon through policy development and tools like the National Australian Built Environment Rating System Embodied Carbon Tool (National Australian Built Environment Rating System 2024). This tool quantifies embodied emissions in new buildings and major refurbishments, facilitating compliance with emerging standards. The Australian National Construction Code is set to incorporate minimum embodied carbon standards by 2028, while government procurement policies increasingly require carbon accounting for infrastructure projects. In August 2023, California became the first state in the United States of America to mandate embodied carbon emission controls in its building code, effective 1 July 2024 (American Institute of Architects California 2023). Large non-residential and school projects must comply with one of three pathways: building reuse, LCA showing 10 per cent carbon reduction or use of low-carbon materials with documented thresholds.

Embedding circularity into the buildings design and construction industry through regulations and incentives, alongside promoting best practices and access to low-carbon and low-cost materials, is essential to driving embodied carbon emissions lower.

2.5. Extended Producer Responsibility in the construction sector

Globally, the construction sector generates an estimated two billion tons of construction and demolition waste (CDW) annually, accounting for approximately one-third of all global waste. Only a small fraction is currently being recycled or reused, with the majority being sent to landfills or incinerated. This linear and unsustainable approach to waste management depletes natural resources and contributes to GHG emissions through the production of new materials, landfill gases and uncontrolled incineration.

Adopting circular construction practices—such as design for flexibility, disassembly, material reuse and enhanced recycling—is essential for significantly reducing waste, conserving resources and mitigating climate and environmental impacts on a global scale. A key enabler of this transition is Extended Producer Responsibility (EPR), a policy approach designed to internalize external costs from waste management and hold manufacturers accountable for the entire life cycle of their products. As the OECD (2001) describes it: "EPR shifts the costs for waste management from public actors to producers. This shift induces an internalization of costs that previously were external for producers and consumers of waste generating products. By internalizing the costs of waste management, producers receive incentives to prevent waste. One of the key channels to prevent waste is eco-design of products." While EPR has traditionally been applied to waste streams like batteries, packaging and electronic products, its application in the construction sector is gaining traction.

Several countries are leading the way in implementing EPR frameworks for construction and demolition waste. France, for example, has introduced a comprehensive EPR scheme for CDW, the Netherlands has an EPR programme for flat glass and India is actively developing its own EPR framework for the construction industry. Though yet to be implemented, Nigeria's

Circular Economy Roadmap emphasizes strengthening and enforcing EPR schemes across key sectors, including construction, to ensure producers are accountable for the full life cycle of their products.

2.5.1 What is Extended Producer Responsibility – the concept explained

In all EPR schemes, regardless of the specific waste stream or product they target, certain general principles and roles consistently apply. A key principle of EPR is the responsibility of producers. In EPR schemes, the term "producer" includes importers and distributors—essentially, any actors bringing the specific product onto the national market (Campbell-Johnston *et al.* 2021). The responsibility of the producer encompasses various aspects, such as paying a fee for the collection and treatment of products, typically calculated based on quantities or the weight of the product (e.g. number of mobile phones or kg of packaging); committing to specific collection and processing targets; and fulfilling reporting obligations. Moreover, producers are tasked to inform consumers on proper disposal methods. To improve transparency, facilitate data collection and avoid free-riding, a register is usually established that includes all obligated producers (Prevent Waste Alliance 2020).

Organizational and administrative responsibilities are often delegated to a third-party entity known as Producer Responsibility Organisation (PROs). PROs are typically tasked with establishing a network of collection points and ensuring that predefined targets are met. They may also allocate portions of the fees paid by producers to fund activities like awareness-raising campaigns. In some EPR systems, only one PRO is responsible for waste management, resulting in a monopolistic setup. However, in most cases, there are multiple PROs. PROs often operate as not-for-profit organizations. In some cases, as in France, this is even required by law. The use of PROs offers the advantage of pooling resources within the recycling sector. By centralizing the eco-contributions of all member producers, PROs can leverage economies of scale to streamline operating costs for waste treatment. This approach enables members to achieve regulatory compliance at the lowest possible cost.

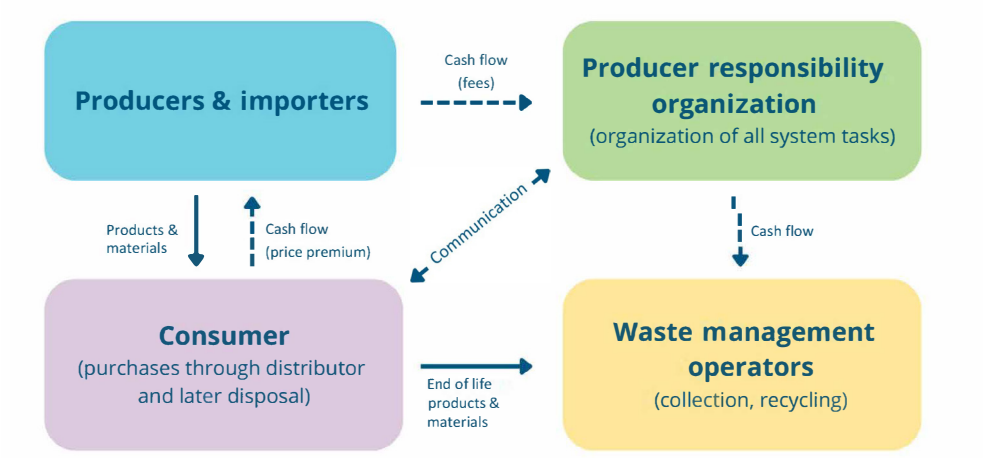

Figure 8. Producer responsibility organization simplified visualization of the general principles (collective system)

Source: own illustration, based on GIZ 2018

Producers can adjust EPR fees to encourage environmentally conscious designs, a practice known as eco-modulation. This approach entails offering lower fees for products designed with environmental factors in mind, such as reduced weight, increased recyclability, durability, repairability, higher recycled content or the absence of hazardous materials, compared to less sustainable alternatives. Recent research (Laubinger *et al.* 2021; Sachdeva *et al.* 2021) underscores that while modulated fees have not yet reached sufficient levels, they do present potential for enhancing upstream circular economy practice.

Through key mechanisms embedded in EPR schemes, such as the development of collection and recycling infrastructure and the application of eco-modulation fees, EPR holds significant potential to create a secondary market for materials, drive business models that align with a circular economy, and incentivize upstream design choices for more environmentally friendly products.

2.5.2 Existing EPR schemes in the construction sector

Construction products often have much longer lifespans compared to other products such as batteries or packaging, where EPR has been implemented for nearly two decades. Additionally, decision-making around product design and end-of-life management is far more dispersed across various actors within the construction value chain. Unlike other sectors, the connection between producers and consumers, who ultimately dispose of the products, is more fragmented and indirect. Despite these challenges, existing and emerging examples demonstrate that EPR can be both feasible and highly impactful in the construction sector. The case studies from below underscore the potential of EPR to address waste management and promote sustainability in even complex industries like construction.

The Netherlands: EPR for flat glass
The Netherlands has implemented an EPR scheme targeting flat insulation glass, introduced in 2022 at the request of the industry to transition from a voluntary agreement to a mandatory EPR under a Generally Binding Agreement (Rijkswaterstaat 2022). Despite prior voluntary efforts, approximately 20,000 tons of flat glass continued to be absorbed into other waste streams annually. By advocating for a mandatory scheme, the industry aimed to create a level playing field by requiring equal financial contributions from all producers to support the operation and maintenance of the waste collection system. Additionally, the scheme sought to enhance the separate collection of flat glass waste.

Under the scheme, producers pay a waste treatment fee of EUR 0.30 per square metre of flat glass sold in the Netherlands, with no differentiation based on glass. These funds are managed by the association Flat Glass Recycling NL (VRN), which serves as the PRO. This includes managing a network (Rijkswaterstaat 2022) of over 2,000 collection points, ensuring that a disposal site is available within 15 km of any location. The waste treatment fee is expected to increase incrementally to account for rising costs. With a price ceiling of EUR 0.40, the VRN can change the height of the waste treatment contribution based on the costs of operating the system.

Glass collected through VRN is processed once it meets quality requirements specified in contracts with waste collection sites. From the collection points, the glass is transported to recycling facilities for reprocessing. Currently, 90 per cent of the flat glass is collected by either the VRN (70 per cent) or other parties (20 per cent) (Rijkswaterstaat 2022). Efforts are ongoing to address the remaining 10 per cent of flat glass that continues to end up in mixed CDW. Promoting the proper separation and collection of this residual waste remains a key focus for the PRO.

France: EPR for construction and demolition waste
France implemented its EPR 2023 encompassing a much broader scope than the Dutch example. The French EPR covers inert waste such as concrete and bricks, as well as other materials like metal, plastics, wood and insulation (France, Le Conseil d'Etat (section des travaux publics) 2021).

This initiative addresses two major challenges: reducing littering and illegal dumping—responsible for nearly 25 per cent of CDW, including asbestos-containing waste (France, Fédération française du bâtiment 2022)—and responding to the sharp decline in landfill capacity by promoting recycling and reuse (France, Ministère de la Transition Écologique 2024). Illegal dumping alone costs France between EUR 340 and 420 million annually for removal and clean-up (France, Ministère de la Transition Écologique 2020).

Under the French EPR scheme, all producers are required to pay an eco-contribution fee for each unit of product placed on the market. The fees, determined by product type, weight or unit length, are revised annually until 2027 to align with the projected waste management budget. The pricing structure is typically collaboratively developed by the PRO (referred to as an eco-organization) and producers, as described in a presentation by PRO Valobat during a stakeholder workshop in Brussels in April 2024. The PROs—in France there are four (one covering only inert waste [Ecominéro], two covering all other products [Ecomaison, Valdélia]

and another covering both [Valobat])—have both collection and recycling targets, which are set out in the EPR regulation, differentiated for the different waste categories (such as inert and non-inert materials) (France, Fédération française du bâtiment 2023).

The EPR regulation mandated the establishment of 2,419 collection points by the end of 2023 (France, Ministère de la Transition Écologique 2023), with specific requirements for their proximity: within 10 km in urban areas and 20 km in rural areas. As described in a presentation by PRO Valobat during a stakeholder workshop in Brussels in April 2024, by September 2024, the largest PRO, Valobat, had already set up 1,435 collection points, partnering with retailers, private collection sites and public authorities to serve municipal waste facilities.

To incentivize waste sorting, a free take-back service is provided, allowing companies to save on landfill taxes and transportation costs, provided that the waste has been sorted (France, Fédération française du bâtiment 2023). Lastly, the regulation sets out eight criteria for eco-modulation of fees: 1) recycled material content, 2) the use of renewable resources, 3) sustainably managed, 4) sustainability, 5) repairability, 6) possibilities of reuse, 7) recyclability and 8) the presence of hazardous substances. While this is a complex task, PROs have commenced developing criteria in 2024, starting with recycled content as the first criteria, incentivizing circular product design (Valobat 2022).

India: Upcoming EPR for construction and demolition materials
Starting in April 2025, India will implement an EPR scheme for the construction sector. Established under the Construction and Demolition Waste Management Rules 2024 by the Ministry of Environment, Forests and Climate Change (India, Ministry of Environment, Forests and Climate Change 2024), this framework covers all materials generated during construction and demolition activities, such as soil, sand, gravel, bricks and masonry, concrete, metal, wood, plastics and other recoverable materials.

A key difference from the previous examples lies in the definition of a producer. In the Indian context, a producer is not the construction product manufacturer but rather the entity directly responsible for waste-generating activities at the construction or demolition site. This includes developers or builders as well as contractors or organizations managing construction, demolition or renovation projects with a built-up era of 20,000 m² and above. The producers will be required to develop waste management plans for all construction, remodelling or demolition projects. These plans must estimate waste volume and outline detailed measures for recycling and disposal. Specific recycling targets apply to inert debris, such as concrete, bricks and tiles. For re-construction projects and demolition projects the target is 50 per cent from 2025–2026 and 100 per cent from 2026–27 onwards (India, Ministry of Environment, Forests and Climate Change 2024). Moreover, producers are mandated to deposit 100 per cent of their waste at authorized processing or storage centres. To ensure accountability, all waste producers must register and report data on waste generation, storage and recycling through a central online platform, which is managed by the Central Pollution Control Board.

Instead of collecting fees from construction product manufacturers based on the quantity of products placed on the market—as seen in the other examples—producers in the Indian scheme fulfil their financial obligations by purchasing so-called EPR certificates. These certificates must be obtained from certified recyclers based on the waste volumes outlined in the waste management plans for the construction project. The revenue generated from the sale of these certificates is split in a 50:50 ratio between the implementing authority and the recyclers. In the Indian model, the fees collected are used for developing recycling infrastructure, funding audits and training programmes, and ensuring compliance.

Additionally, the Solid Waste Management Rules, which set out the framework for EPR, mandate the use of secondary raw materials and reuse in new construction projects that exceed 20,000 m², and road construction. The quota starts at five per cent for 2026/27 and increases every two years, reaching 25 per cent by 2030 (India, Ministry of Environment, Forests and Climate Change 2024).

2.5.3 The potential of EPR in the construction sector – conclusions

While details of existing schemes are still evolving and various design options are under consideration, it is evident that EPR systems hold significant potential to drive circular business models and raise awareness of sustainable design and use of construction materials. The case studies demonstrate how EPR systems can be tailored to meet the unique needs of different national contexts. For example:

- The Netherlands, where recycling practices are well established, adopted a focused approach targeting a single product group (flat insulation glass) to address a specific issue.
- France, in contrast, implemented a broad EPR scheme for CDW to tackle the widespread problem of illegal dumping and its financial burden for municipalities.
- Regulatory frameworks also differ, with France embedding a mandatory EPR in its anti-waste law and specifying roles and responsibilities in an ordinance, while the Netherlands relied on voluntary agreements with industry before transitioning to a mandatory model.
- India is exploring its own EPR framework, which uses a different definition of producers—focusing on builders rather than manufacturers—and does not include a PRO. Instead, producers purchase EPR certificates from certified recyclers, the revenues from which are used for raising awareness and improving the recycling infrastructure.

EPR schemes can drive higher and better quality recycling rates by establishing a better collection network and providing free take-back services for sorted materials at designated sites. These measures reduce costs associated with landfill taxes and transportation, making higher-value recycling more attractive and fostering secondary markets for materials.

Beyond recycling, EPR can also support reuse by enabling local networks of storage points and creating marketplaces, such as digital platforms or catalogues, for building components suitable for reuse. PROs can play a vital role in promoting reuse by engaging planners and designers to adopt principles like “design by availability”, where construction projects incorporate available reused materials. To encourage upstream innovation, modulated fees within EPR schemes can incentivize the development of environmentally friendly products. By prioritizing recyclability, durability or use of recycled content, these fee structures can influence design practices and material choices in the construction sector.

To improve circularity in the sector, EPR schemes need to be integrated with other policies: To ensure the economic viability of EPR, countries should consider implementing landfill bans or landfill taxes for CDW. Where these do not exist, mandatory construction waste management regulations should be introduced to increase the volumes and quality of recovered materials. Additionally, it is essential to integrate EPR with policies that stimulate the demand for secondary materials. While individual building owners are starting to show interest in reusable building elements or recycled materials, it remains far from mainstream. Commitments in public procurement can play a vital role in creating this demand. Public projects prioritizing circular materials can set a standard and create market momentum for secondary solutions.

Amidst various recent policy developments such as initiatives to assess and disclose life cycle carbon emissions or recycled content standards, aligning different environmental objectives is key. Bringing together diverse stakeholder communities focused on circular economy practices, energy efficiency improvements and life cycle carbon is critical for cohesive progress. By fostering collaboration, they can better understand the impact of improved durability, repairability and reuse on environmental performance metrics such as whole life carbon emissions. For example, policies related to setting whole life carbon emission thresholds and reduction targets prompt questions about the role of durable products, improved repairability and higher use of secondary materials in achieving these objectives. Addressing these questions collectively through collaboration and knowledge exchange will provide the insights needed to drive meaningful action. This integrated approach will not only help achieve climate targets but also advance circular economy principles, creating synergy between sustainability goals.

Photo: Unsplash

Chapter 3 Sustainable buildings and construction policies

National policies, building energy codes and standards, NDCs, and green building certifications form an interconnected policy framework that act to accelerate the buildings sector's transformation toward being highly energy efficient, zero carbon and resilient to climate change. National policies provide the strategic foundation, setting long-term goals and aligning incentives to drive resilience and sustainable practices. National policies should aim to incorporate equity and gender-responsive strategies, setting long-term goals that promote gender equality and align incentives to drive sustainable and inclusive practices. Policies should promote gender and cultural diversity to have equal access to opportunities and benefits in the buildings sector. Building energy codes and performance standards operationalize these policies by establishing enforceable performance standards, offering pathways for compliance and fostering innovation. NDCs, on the other hand, integrate these efforts into global climate commitments, enabling countries to align national actions with international targets. Green building certifications complement these initiatives by rewarding exemplary projects, driving market demand for sustainable practices and setting benchmarks for innovation.

In the buildings sector, diverse policies significantly influence decarbonization efforts, with their success often depending on strategic design and implementation. Progressive regulatory measures such as building energy codes, emission standards and energy efficiency mandates all aim to ensure baseline improvements in resilience and energy use, particularly in new constructions and renovations. These are complemented by market-based tools like carbon pricing and emissions trading schemes, which incentivize lower carbon choices by internalizing the environmental costs of energy consumption. Adopting subsidies and financing mechanisms that make resilient construction and low-carbon design and energy-efficient technologies more accessible, encourages a broader adoption among homeowners and businesses. Recent analysis covering the period 1998–2022 (Stechemesser *et al.* 2024), showed that the most numerously adopted policies to address mitigation in the buildings sector include: building codes, labels and performance standards for appliances, subsidies, financing, carbon taxes and fossil heating bans (Figure 9). The analysis showed the importance of combining policy efforts with combinations of regulations and bans with subsidies and pricing incentives.

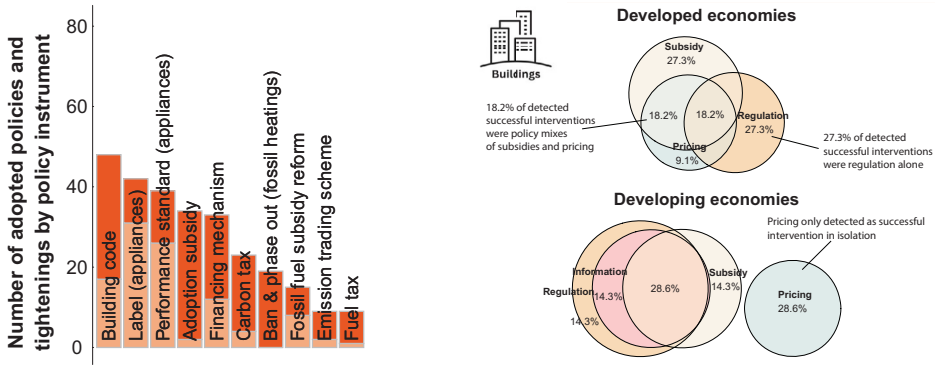

Figure 9. a) Policy instruments adopted for mitigation impact in the buildings sector; b) Effective policies and policy mixes (Stechemesser *et al.* 2024)

3.1 National policy efforts for decarbonizing and adapting the buildings sector

As countries intensify their efforts to reduce emissions in the buildings and construction sector and strengthen commitments through international collaborations like the Buildings Breakthrough and the Chaillot Declaration (COP26 Presidency 2021; Building and Climate Forum 2024), it becomes essential to track and evaluate how detailed and well-integrated these country-level policies are.

The following countries are highlighted to showcase the existing policy landscape of the sector in terms of mitigation, adaptation and recent efforts to support sustainability of the buildings sector through enabling actions such as funding or incentives.

South Africa has introduced several policies and initiatives to promote building decarbonization and energy efficiency. Its National Building Regulations mandate energy efficiency standards for new buildings and renovations, requiring measures such as insulation to meet specific performance criteria (South African Bureau of Standards [SABS] 2021). Additionally, the voluntary SANS 204 standard outlines higher energy efficiency requirements for green building certification (SABS 2011). The National Energy Efficiency Strategy targets a 15 per cent improvement in commercial building efficiency, supported by tax incentives for verified energy savings (South Africa 2008). Decarbonization efforts in the construction sector include reducing reliance on emissions-intensive materials like steel and cement through improved spatial planning and material reuse. Supply-side measures, such as renewable energy-based electrification and retrofitting existing buildings, are prioritized to lower operational emissions. These strategies align with South Africa's broader goals of achieving net zero emissions while addressing housing inequality and fostering economic growth through job creation in sustainable construction practices.

Rwanda's energy efficiency and decarbonization strategies incorporate regulatory measures, economic incentives and institutional reforms. Energy efficiency policies include the incorporation of the National Cooling Strategy into building codes, implementation of minimum energy performance standards for key products and mandatory energy audits for industries and buildings. Economic incentives such as subsidies for solar water heaters and bulk procurement of energy-efficient technologies like LED lamps aim to reduce barriers to adoption. The country's energy roadmap highlights potential annual savings of US$25 million resulting from an expected 22 per cent reduction in electricity consumption, with an estimated investment opportunity of US$91 million.

According to China's Third Biennale Update Report (China 2023), goals have been set for the buildings sector at both national and regional levels, although targets are not mentioned. The report highlights measures such as raising energy saving standards for new buildings, expanding energy-efficient renovations of existing structures and encouraging the integration of renewable energy. In March 2024, China introduced an action plan to further enhance energy conservation and carbon reduction in the construction sector, with the objective to establish a robust institutional framework by 2025 and to scale up ultra-low energy consumption buildings by 2027. Regarding adaptation, the National Climate Change Adaptation Strategy 2035 outlines measures to bolster the sector's resilience against climate impacts, including the development of climate-adaptive urban infrastructure and the implementation of early warning systems for climate-related disasters.

Mexico has a commitment to reduce 66 per cent of emissions of residential and commercial buildings by 2030. This has been supported by the implementation of diverse norms for energy efficiency: for electrical and thermal energy, energy efficiency in public administration, and for small- and medium-sized enterprises. Nevertheless, a long-term goal or roadmap for the decarbonization of the buildings sector is not yet established. In terms of adaptation, one of the main objectives of the special programme for climate change includes the increase of resilience of productive systems and strategic infrastructure. Mexico City includes the plan for the city's resilience within its programme for climate action, however, there is not a dedicated strategy for buildings.

Colombia has a roadmap for net zero buildings in 2050, with new buildings being zero-emissions from 2030, and all buildings by 2050. Nevertheless, dedicated new policies to support the roadmap's implementation have not been created. It is important to note that Colombia is one of the countries leading the market for green building certificates in Latin America. It intends to achieve the goal of 50 per cent of new residential buildings delivered until 2030 being certified green. The country has also rolled out some tax alleviation schemes to support the use of energy-efficient appliances in buildings.

Germany aims to achieve a 65 per cent reduction in CO_2 emissions from buildings against 1990 under its Federal Climate Change Act. The country currently stands at a 42 per cent reduction from 1990 levels. Key mitigation measures include the Building Energy Law, reducing 3.08 Mt CO_2e by 2025, Reconstruction Loan Corporation (KfW)/Federal Office for Economic Affairs and Export Control subsidies for energy-efficient construction and renovations (- 6.9 Mt CO_2e), tax incentives for refurbishment (-1.6 Mt CO_2e) and CO_2 pricing for heating and transport (-0.15 Mt CO_2e). Adaptation efforts are guided by the German Strategy for Adaptation to Climate Change, featuring programmes for urban climate adaptation, energy-efficient urban refurbishment and measures to address climate change impacts.

France has committed to reducing GHG emissions in the buildings sector by 40 per cent by 2030 compared to 1990 levels, with a long-term goal of achieving carbon neutrality and net zero energy construction by 2050. This commitment is supported by regulations such as the Thermal Regulation 2012, which sets strict energy consumption limits for new buildings, and the Environmental Regulation RE2020, which integrates life cycle carbon analysis into building design. The Décret Tertiaire requires landlords and occupants of buildings greater than 1000m² to reduce their energy consumption by at least 40 per cent in 2030, 50 per cent in 2040 and 60 per cent by 2050. On adaptation, the Climate and Resilience Law prioritizes integrating climate resilience measures in buildings, addressing challenges such as heatwaves, heavy rainfall and flooding. The National Adaptation Plan strengthens building resilience, complemented by regional initiatives like the Climate-Air-Energy Plans. Financing mechanisms, including MaPrimeRénov' and the OPERAT platform, enable retrofitting, energy consumption tracking and certifications to support both mitigation and adaptation goals.

Tunisia aims to enhance energy efficiency and reduce emissions in the buildings sector, targeting a 45 per cent reduction in carbon intensity by 2030. Key initiatives include the Energy Transition Program for Public Buildings, deploying solar PV systems, and promoting energy efficiency under the Energy Transition Strategy. To adapt to climate challenges, Tunisia focuses on resilient infrastructure to address heat stress, water scarcity and urban flooding through urban adaptation plans. These efforts are supported by the Energy Transition Fund, international partnerships with organizations like GIZ, and resources from the Green Climate Fund.

Current United Kingdom policies for mitigating and adapting the buildings sector focus on supporting net zero carbon emissions by 2050, with a 78 per cent reduction by 2035 (United Kingdom Green Building Council 2024). Key strategies include retrofitting existing buildings to improve energy efficiency, prioritizing low-carbon materials and implementing whole-life carbon assessments for construction projects. Adaptation policies, outlined in the Third National Adaptation Programme, have included updating building regulations to address overheating and other climate risks.

Nigeria is advancing efforts to decarbonize its buildings sector, targeting a 43 per cent reduction in emissions by 2030 and a 97 per cent reduction by 2060 under the Renewable Energy Scenario outlined in its Long-Term Low-Emission Development Strategy (Nigeria, National Climate Change Council 2023). It aims to achieve these targets by transitioning to renewable energy, electrifying energy end-uses, accelerating uptake of energy-efficient technologies and encouraging green building practices. The strategy highlights the growing recognition by policymakers of the buildings sector's critical role in achieving net zero emissions.

Viet Nam is committed to achieving net zero emissions by 2050. To fulfil this commitment, the country has developed a plan to implement a roadmap for reducing GHG emissions in the construction sector, aiming to establish a pathway for emissions reduction in urban development, building construction and building materials manufacturing (United States, International Trade Administration 2024). The development of the GHG reduction roadmap for the construction sector began in 2024 and is expected to be completed by 2026. Additionally, regulations for energy-efficient construction practices have been updated. The standards for LCAs of buildings and environmental product declarations will be formulated to align with Viet Nam's context. GHG inventory plans for construction projects will become mandatory in 2025 for projects emitting over 3,000 tons of CO_2 equivalent. Furthermore, the development of social housing is also a priority in line with the goal of reducing carbon emissions. Projects that achieve green building certifications such as LEED, EDGE, Lotus and Green Mark are encouraged, with over 500 projects having received certification. In 2024 alone, the number of green building certifications surpassed 200, demonstrating the trend toward investment in carbon emission reduction projects. To implement the GHG reduction plan, support for financing, green investments and especially the carbon credit trading market will be initiated in 2028.

3.2 Building codes

Building codes (including energy codes) provide a highly effective approach to reducing building-related emissions and enhancing resilience. Building energy codes are regulatory instruments designed to set minimum energy efficiency standards for residential and non-residential buildings. These codes play a crucial role in reducing energy consumption, which is significant given that buildings are major consumers of energy globally.

Strong, right-sized and enforceable building codes are the simplest approach to enhancing the reliability and resilience of buildings and infrastructure. When properly enforced, building codes provide resilience against the current and growing impacts of extreme weather events exacerbated by climate change. Integrating resilience into building codes is essential to address the growing impacts of extreme weather events exacerbated by climate change (International Code Council [ICC] 2022). This involves incorporating comprehensive risk assessments to identify regional hazards and guiding land use away from high-risk zones. Furthermore, linking post-disaster recovery plans to building codes in tandem with community resilience programmes with a strong focus on capacity-building will enhance disaster preparedness. Regular reviews of building codes are crucial to include the latest scientific research and adapt to emerging risks, ensuring that building practices align with contemporary environmental and societal needs, ultimately strengthening resilience and achieving mitigation targets. A study conducted on national building codes, utilizing input from signatories to a Knowledge Sharing Partnership, established among member organizations, highlighted the paramount significance of effective national building codes in fostering safe, resilient and sustainable communities (Commonwealth Association of Architects 2024). These codes are instrumental in addressing a wide array of public health and safety challenges, promoting rigorous construction practices, enhancing energy efficiency and setting standards for construction quality. The survey revealed significant gaps in coverage among national building codes in both Official Development Assistance (ODA) and non-ODA countries. Only 11 per cent of respondents in ODA countries have adopted a mandatory energy code, which is vital for achieving climate objectives, while 10 per cent of national building codes in ODA countries address essential aspects such as materials and workmanship, critical for reducing the high incidence of building failures.

As of 2024, 85 countries have adopted national building energy codes for residential buildings, and 88 countries have adopted national building energy codes for non-residential buildings, of which 80 per cent are mandatory (see Figure 10). However, 20 per cent of mandatory codes pre-date 2015 and should be updated to align with current technological realities and international best practices. Twenty of these codes have been updated and adopted since 2022, and five countries updated their building energy codes in 2024, including Kenya, Iceland, Japan, Germany and Viet Nam.

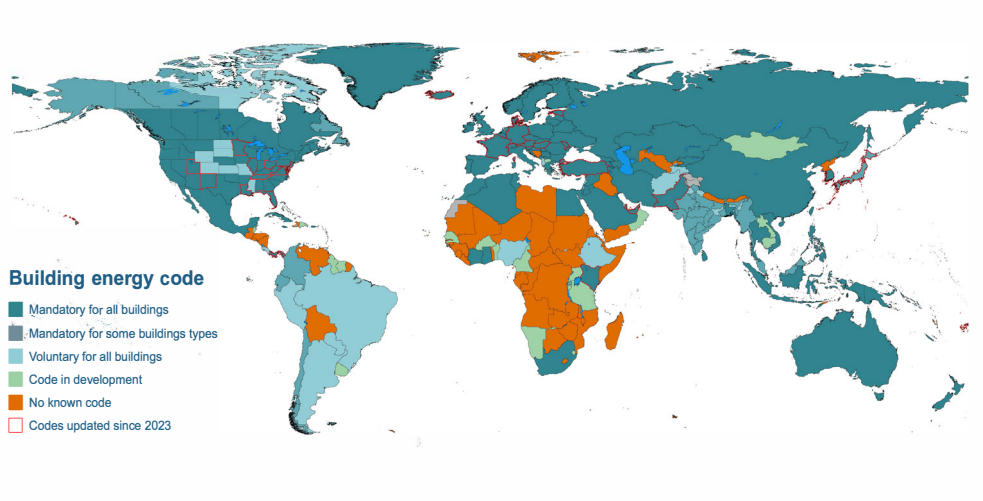

Figure 10. Adopted global building energy codes by type and status (IEA 2024d)

Notes: This map is without prejudice to the status of or the sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area. Countries and states with dark 'red' outline have adopted updated building energy codes since 2023.

The 2024 German Building Energy Act enforces stricter energy efficiency standards, reducing annual primary energy demand for new buildings from 75 per cent to 55 per cent of prior benchmarks (Germany 2020). It mandated that all newly installed heating systems in new construction areas use at least 65 per cent renewable energy from 1 January 2024. Additionally, energy performance certificates are required to document building efficiency, and the act promotes intelligent building automation to improve energy performance, aligning with Germany's climate neutrality goal by 2045.

Kenya's Building Code, launched in March 2024, introduces energy performance standards that enhance efficiency and sustainability in the construction sector (Kenya 2024). It encourages energy-efficient building designs, promotes renewable energy integration and advocates for the use of energy-saving materials and technologies. It also mandates the inclusion of electric vehicle charging ports in new buildings.

Iceland updated its building energy code to include mandatory LCAs for new building permits, with these requirements coming into effect on 1 September 2025 (Iceland 2024). This update is part of a broader effort to reduce the environmental impact of the construction sector and promote sustainability. A transitional period has been introduced to help stakeholders adapt to the new regulations, which focus on evaluating the entire life cycle of building materials to address climate change impacts.

In 2024, two states (Florida and Illinois) in the United States of America updated their building energy codes to the International Energy Conservation Code (IECC) 2021 version of the residential or commercial building energy codes, with 15 further states upgrading to a higher performance version (United States, Department of Energy 2024). The 2021 IECC establishes energy efficiency standards for residential and commercial buildings, aiming to reduce energy consumption, promote sustainability and lower GHG emissions. The 2021 edition updates building envelope standards, energy-efficient lighting and mechanical systems, with higher insulation, efficient windows and blower door testing for residential buildings, and efficient HVAC, daylighting and energy monitoring for commercial buildings. Under the Infrastructure Investment and Jobs Act, US$225 million is allocated for energy code implementation through the Resilient and Efficient Codes Implementation programme. The Inflation Reduction Act provides US$1 billion for Building Code Technical Assistance, including US$330 million for adopting the 2021 IECC and US$670 million for adopting codes meeting or exceeding zero energy standards in the 2021 IECC (ICC 2021).

In Nigeria, Lagos State's forthcoming Building Code (Public Sector Global 2024), set for introduction in 2025, establishes high-performance standards to drive energy efficiency and sustainability in the state's buildings and construction sector. The code requires energy-efficient designs for new buildings and encourages renewable energy integration and use of

low-carbon materials. Additionally, it includes provisions for installing electric vehicle charging infrastructure in new developments.

Despite encouraging progress, the amount of new construction still not covered by building energy codes remains a major concern. The IEA estimates that over 50 per cent of buildings constructed globally—around 2.55 billion square metres—are not covered by such codes or performance standards (Figure 11). Without the adoption of building energy standards in countries that lack coverage, there is no effective mechanism to ensure that buildings are energy efficient, affordable or designed to safeguard human health and comfort. Additionally, this lack of coverage puts at risk the global goal of all new buildings and all buildings being net zero carbon respectively by 2030 and 2050.

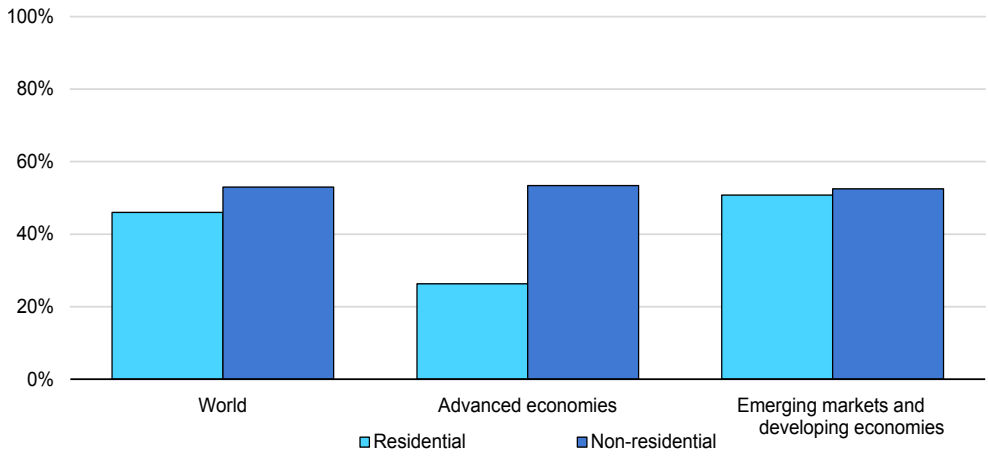

Figure 11. Portion of newly built floor area not covered by building regulations in 2023 (IEA 2024a)

Several model codes for supporting the objective of achieving zero carbon buildings exist, such as the International Code Council's IECC and International Green Construction Code, the National Energy Code of Canada for Buildings, and the recent United Kingdom Zero Carbon Code, which all provide achievable pathways toward zero-carbon buildings (see Box 3). Although these standards vary in terms of their obligation, they each present an approach that seeks to ensure building energy performance is elevated to a high standard and that available resources are used to minimize carbon emissions, such as through onsite and offsite renewable energy generation.

BOX 3. ZERO-CARBON EMISSIONS BUILDINGS ENERGY STANDARD EXAMPLES

Canadian Green Building Council – Zero Carbon Buildings Standard

The Canadian Zero Carbon Building (ZCB) Standard (Canada Green Building Council 2024), developed by the Canada Green Building Council, provide a framework to guide the design, construction and operation of buildings with net zero carbon emissions. These standards are integral to Canada's strategy to decarbonize the buildings sector, targeting both new constructions and existing buildings through two distinct certification pathways: the Zero Carbon Building Design Standard and the Zero Carbon Building Performance Standard. The Design Standard focuses on embedding zero-carbon principles from the outset in new constructions and major renovations, emphasizing strategies such as reducing energy demand, improving energy efficiency and minimizing embodied carbon through high-performance building envelopes and the use of low-carbon materials. Meanwhile, the Performance Standard ensures that operational buildings achieve and maintain net zero carbon status over time, requiring continuous monitoring and optimization of energy performance.

Central to these standards is the Thermal Energy Demand Intensity (TEDI), which measures the annual heating energy required per unit area. TEDI targets are climate-specific, ranging from 15 kWh/m²/year in milder climates to 40 kWh/m²/year in colder regions, thereby ensuring that buildings are energy efficient relative to their environmental contexts. The ZCB Standards mandate comprehensive carbon accounting that addresses both operational carbon, linked to building energy use, and embodied carbon, associated with material production and construction processes, thus promoting the use of low-carbon solutions. Additionally, the standards require buildings to incorporate on-site renewable energy generation or procure renewable energy credits to offset emissions, aligning with Canada's national climate objectives.

In comparison to the National Energy Code of Canada for Buildings (NECB) 2020, the ZCB Standards offer a more holistic approach by addressing both energy efficiency and carbon emissions, including embodied carbon, and mandating the integration of renewable energy to achieve net zero status. While the NECB focuses primarily on improving energy efficiency through a tiered framework, without explicit carbon emission targets or embodied carbon considerations, the ZCB standards provide specific targets for energy use and thermal energy demand, often resulting in higher energy performance. This comprehensive approach by the ZCB standards aims not only to enhance building sustainability and resilience but also to provide a measurable pathway to significantly reduce the environmental impact of buildings across Canada's diverse climate regions.

United Kingdom Net Zero Carbon Buildings Standard

The United Kingdom Net Zero Carbon Buildings Standard (UKNZCBS) offers a comprehensive framework designed to decarbonize the built environment and is aligned with the United Kingdom's legally binding target of achieving net zero emissions by 2050 (United Kingdom, Net Zero Buildings UK 2024). Developed through collaboration with industry experts, the standard establishes rigorous benchmarks for both operational energy use and embodied carbon, focusing on renewable energy integration across new and existing buildings. By adopting a life cycle approach, the standard addresses emissions from material production, construction, use, maintenance and end-of-life disposal, ensuring reductions in construction-related and operational emissions. Any residual emissions must be offset through verified schemes to ensure a net zero outcome.

For operational energy, the standard sets clear targets such as a maximum Energy Use Intensity of 45 kWh/m²/year for new residential buildings and a cap on residential space heating demand at 20 kWh/m²/year. Regarding embodied carbon, it limits emissions for construction materials, with an example target of 430 $kgCO_2/m^2$ for homes built in 2025. The UKNZCBS also mandates the integration of renewable energy, requiring buildings to generate a significant portion of their energy on-site, while prohibiting the use of fossil fuels and high Global Warming Potential refrigerants.

The UKNZCBS emphasizes transparent reporting and verification, utilizing standardized methodologies like the Royal Institution of Chartered Surveyors Whole Life Carbon Assessment to enhance credibility. It provides flexibility with sector-specific pathways, accommodating the diverse carbon profiles of residential, commercial and industrial buildings. By fostering energy efficiency and innovation, this standard aims to reduce the construction sector's GHG emissions, which account for approximately 25 per cent of the United Kingdom's total emissions. By advancing climate-resilient and energy-efficient buildings, the UKNZCBS not only supports national climate goals but also contributes to broader sustainability and economic objectives.

International Energy Conservation Code 2021 and 2024 editions – Zero energy code

The International Energy Conservation Code (IECC) provides a framework to achieve net zero energy buildings by emphasizing energy efficiency and renewable energy integration. Developed through the International Code Council (ICC), it includes optional appendices for residential and commercial buildings, designed to reduce energy consumption and GHG emissions, and support sustainable construction. The Residential Zero Code Appendix requires homes to exceed baseline energy efficiency standards and achieve an Energy Rating Index score of zero through the integration of renewable energy, either on-site, such as rooftop solar, or off-site, like renewable energy credits or community solar programmes. The Commercial Zero Code Appendix, based on Architecture 2030's ZERO Code, combines minimum energy efficiency compliance with renewable energy to offset the building's annual energy consumption. The 2024 edition of the IECC also includes appendices for commercial and residential buildings that provide a pathway to achieve net zero energy buildings by 2030 (ICC 2024b).

The code prioritizes energy efficiency first, mandating compliance with or exceeding the baseline standards of the 2021 or 2024 IECC. After efficiency requirements are met, renewable energy systems are used to address remaining energy needs. While the code focuses on energy use reduction, it recognizes that achieving net zero energy does not eliminate carbon emissions if fossil fuels are still used for heating or other functions. With its scalable and flexible approach, the ICC Net Zero Energy provisions support jurisdictions in advancing climate goals and promoting sustainable building practices.

3.3 Tracking modern building energy codes

Modernizing building energy codes to include requirements and features that better support the transition of the buildings sector towards greater energy efficiency and lower carbon emissions is critical to achieving global emissions targets, even amidst the rapid pace of urbanization and expansion of the built environment.

Modern building codes must address a wide range of considerations if they are to deliver high energy efficiency, enhance sustainability, combat climate change and ensure optimal thermal comfort in buildings (IEA 2023b). Building energy codes are crucial for promoting energy efficiency in new construction, and integrating smart features within these codes is essential for enabling building-to-grid interactivity. These codes should set minimum requirements for building fabrics, technical systems performance and overall building performance.

Furthermore, they must not be static but should integrate provisions for a progressive improving of requirements over time. Additionally, these codes can promote renewable energy adoption and innovative technologies, enhancing energy system resilience. Implementing and enforcing building energy codes in emerging economies can help mitigate climate change, improve energy security and reduce the buildings sector's carbon footprint, while increasing energy security. In rapidly developing and urbanizing countries, modern building codes are vital for managing future energy demand and reducing carbon emissions. Energy codes are an immediate strategy for improving building performance and should be part of a comprehensive policy package supporting high-performance buildings.

In an effort to track adoption of modernized building energy codes, the IEA produced the Building Energy Code Content Assessment (BECCA) (IEA 2024d). The framework sets out key indicators for features that should comprise best practice modern building codes (see Table 1). These include: most recent update, obligation requirements, sector coverage, described measures of compliances, requirements for new and existing buildings, energy efficiency requirements, energy management requirements, smart solutions, onsite renewables and zero-carbon readiness.

Table 1. Elements of the Building Energy Code Content Assessment (IEA EEMR 2024)

BECCA element	Description
Obligation	Is the compliance with the building energy code (BEC) voluntary or mandatory?
Last update	Has the BEC been recently updated (e.g. in the past five years) with the assumption that newer codes will have incorporated advancements in energy efficiency and sustainability?
Coverage	Does the BEC cover all buildings, or only part of the buildings stock (e.g. above a certain threshold for floor area or energy consumption, only non-residential buildings)?
Compliance mechanism	Does the BEC describe compliance requirements and mechanisms to follow in a comprehensive or limited manner?
New/existing buildings	Does the BEC have requirements only for new construction or does it apply to existing buildings when being upgraded?
Energy efficiency requirements	Does the BEC set requirements for a building's overall energy performance and/or requirements for buildings components, energy using services and building fabric?
Energy management systems	Does the BEC include requirements for energy management for buildings operations?
Smart solutions	Does the BEC require the use of smart features, such as electric vehicle charging, onsite energy storage, smart metering, communication protocols and demand response devices?
Onsite renewables	Does the BEC include requirements for onsite renewable energy generation?
Zero-carbon readiness	Does the BEC have a stated objective of achieving nearly or net zero energy and/or carbon emissions?

The IEA reviewed a number of country codes using the BECCA method and found that there are varied approaches to energy efficiency and sustainability features being adopted in codes (see Figure 12) (IEA 2024d). Energy efficiency requirements are the most consistently adopted feature for both residential and non-residential buildings, underscoring their importance in reducing energy consumption. Onsite renewables, such as solar panels, are incorporated in some codes (e.g. Germany and Italy, and Washington, D.C.) and often prioritize non-residential buildings, though overall adoption remains inconsistent. Compliance mechanisms, i.e., ensuring adherence to codes, are widely adopted but vary in strength, with some country codes incorporating strict enforcement provisions (for example Australia, the United Kingdom and the

United States of America have explicit requirements on enforcement). Zero-carbon readiness, which aligns buildings with either nearly or net zero emission goals, is less prevalent and remains an emerging focus area. Smart solutions, such as smart controls or digital logs, are included by only a few countries, indicating untapped potential.

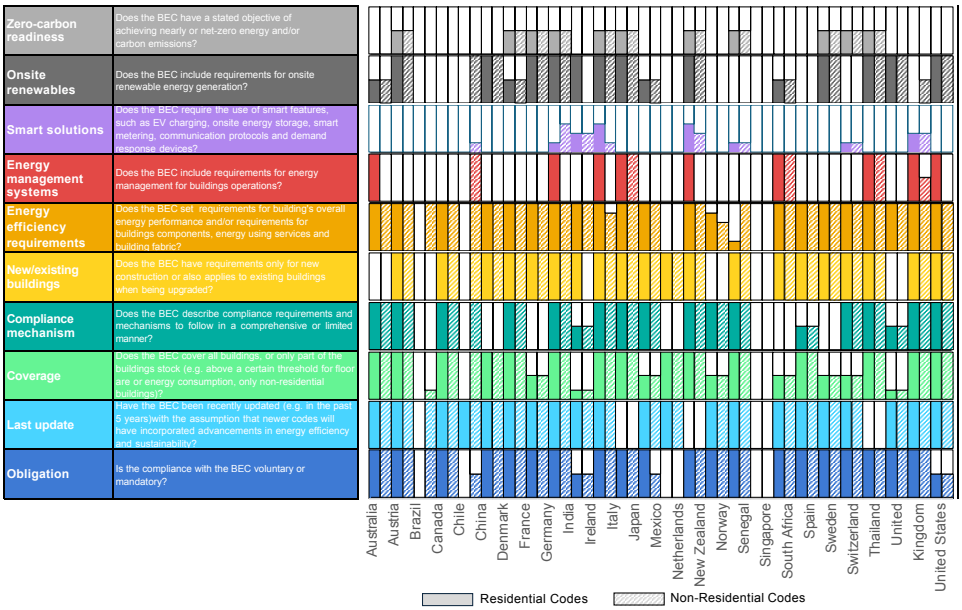

Figure 12. Building energy code content analysis (IEA 2024d)

3.4 Nationally Determined Contributions updates

NDCs are a critical mechanism for achieving the Paris Agreement's overarching goal of limiting global warming to no more than 1.5°C above pre-industrial levels. Within the context of the buildings and construction sector, NDCs can drive actions to promote sustainable practices and energy efficiencies, and can encourage innovations in low-carbon construction materials and technologies. As of November 2024, 194 countries plus the European Union have submitted NDCs to the United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC 2024a) (see Figure 13). As of 2024, 80 per cent of NDCs cite actions for the buildings and construction sector, 19 of which covered the sector in extensive detail (see Table 2)

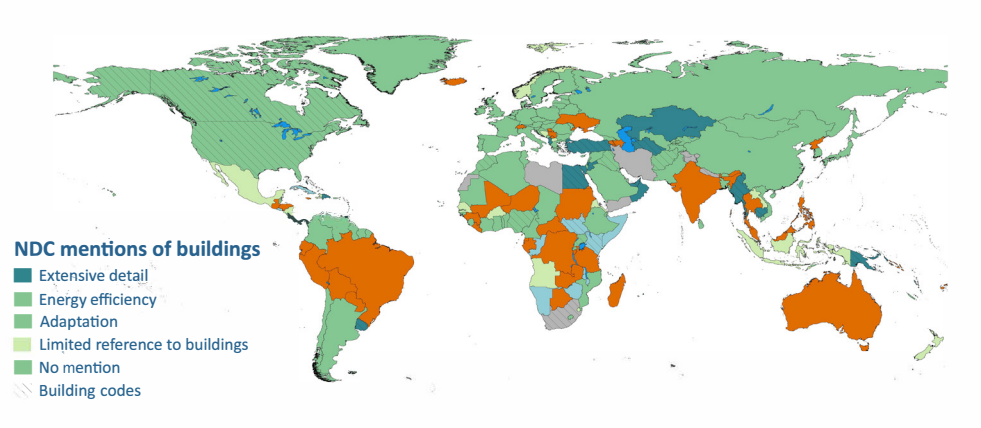

Figure 13. Mentions of buildings in Nationally Determined Contributions (NDCs)

Notes: This map is without prejudice to the status of or the sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

In 2023, 38 parties updated their NDCs, however, in 2024, only three parties adjusted or updated their NDCs. They are Panama, Madagascar and Namibia. Panama continues to set out details on adaptation and energy efficiency for the buildings sector, while Namibia highlights renewable targets for hot water in buildings. A review by the Programme for Energy Efficiency in Buildings (PEEB) and the Global Alliance for Buildings and Construction (GlobalABC) of 194

countries' NDCs showed that 84 per cent included measures for the buildings sector (PEEB and GlobalABC 2024). Mitigation dominates, with 80 per cent addressing it, primarily through energy-efficient design (68 per cent), efficient appliances (62 per cent) and renewable energy (43 per cent).

However, only 18 per cent of NDCs feature quantifiable mitigation targets, and even fewer (16 per cent) outline funding strategies and resource availability, indicating a significant gap in enabling ambition (see Table 2) (PEEB and GlobalABC 2024). Adaptation measures are included in 53 per cent of NDCs, focusing on structural strengthening (40 per cent), site planning (32 per cent) and climate risk awareness (11 per cent), but resilience-specific actions remain sparse. The coverage of buildings in NDCs has also grown regionally, with Africa and Asia leading in proportions that include the buildings sector at 94 per cent and 89 per cent, respectively, while high-income nations trail at 73 per cent.

However, the PEEB and GlobalABC report highlights that many NDCs lack a holistic, life cycle approach, addressing isolated aspects like energy efficiency without integrating embodied carbon or circularity. Greater consistency in detail, robust quantitative targets and inclusive language that encompasses informal housing are also clearly needed if NDCs are to drive comprehensive and impactful climate action in the buildings sector.

Table 2. Mentions of buildings in NDCs as of October 2024

Global Status Report Year	2021	2022	2023	2024
Adaptation only	17	20	17	17
Energy efficiency	94	103	106	106
Extensive detail	10	15	19	19
Limited reference to buildings	14	16	15	15
No known NDC	5	3	3	3
No mention	56	39	37	37
Total mentioning buildings	135	158	161	161
Total	196	196	197	197

Source: Kennard 2024

3.5 Guide to developing NDC 3.0 for the buildings sector

The next phase of NDCs (NDC 3.0) will need to incorporate deeper integration of net zero strategies for the buildings and construction sector, focusing on decarbonization pathways, circular economy principles and increased collaboration between governments and industry stakeholders.

NDC 3.0 represents the next generation of NDCs, emphasizing ambitious, sector-specific climate goals aligned with the 1.5°C target. For the buildings sector, this is a critical opportunity to decarbonize, enhance energy efficiency and adopt sustainable practices, addressing the sector's significant share of global emissions while unlocking economic and environmental benefits.

The recently launched report *NDCs for Buildings: Ambitious, Investable, Actionable and Inclusive – Guidance for Policymakers and Practitioners in the 2025 NDC Revision* by PEEB and GlobalABC provides a comprehensive framework for integrating ambitious, investable, actionable and inclusive measures into NDCs for the buildings sector (PEEB and GlobalABC 2024). The report outlines a five step approach: 1) assessing country circumstances, 2) identifying measures, 3) selecting sectoral actions, 4) enabling implementation and 5) and ensuring quality (see Figure 14). To help gauge readiness levels, the steps align to three market maturity stages: building foundations, expanding and enhancing, and achieving net zero resilience.

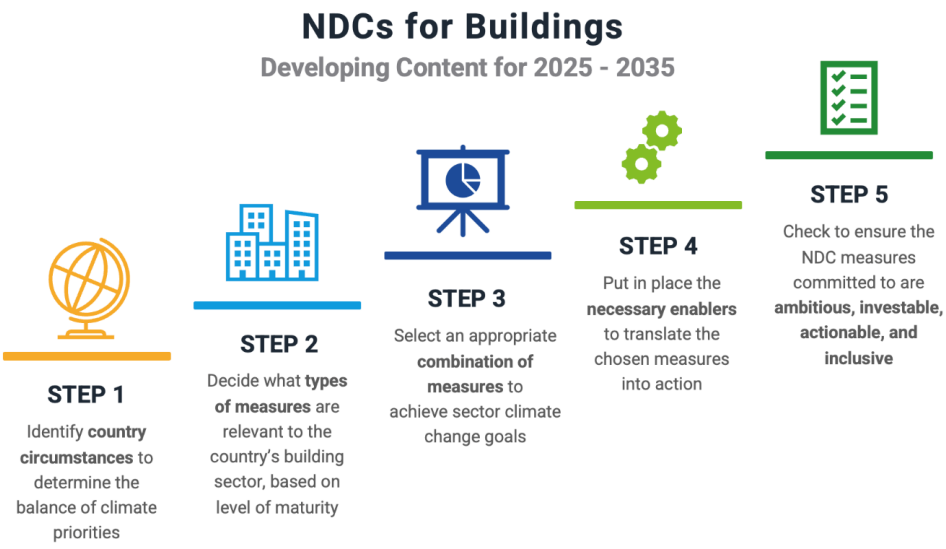

Figure 14. Five simple steps to develop built environment content in NDCs (PEEB and GlobalABC 2024)

The five steps aim to develop effective NDCs for the buildings sector through five key steps that align with three stages of market maturity, which include:

- **Step 1** assesses country circumstances by evaluating GHG emissions, climate risks and technical capacities. Stage I countries should focus on foundational assessments of emissions sources and vulnerabilities, while Stage II and III countries can refine priorities, addressing embodied carbon and resilience planning.
- **Step 2** identifies relevant types of measures, such as building energy codes, retrofits and renewable energy integration. Stage I focuses on basic energy efficiency, Stage II emphasizes circular economy and equity-focused policies and Stage III integrates advanced measures like zero-carbon operational and embodied building designs.
- **Step 3** involves selecting sectoral measures using a menu of policy options and setting specific, measurable, achievable, relevant and time-bound targets. For Stage I, these targets address initial GHG reductions, while Stage II and III focus on life cycle carbon reductions and climate-resilient urban planning.
- **Step 4** establishes enabling conditions, addressing barriers such as financing gaps and capacity-building. Stage I can prioritize public awareness and green financing, Stage II integrates governance frameworks and Stage III adopts cutting-edge monitoring, reporting and verification systems.
- **Step 5** ensures NDCs are ambitious, investable, actionable and inclusive by setting scalable, net zero-compatible targets and embedding inclusive strategies like affordable housing. By tailoring each step to market maturity, NDCs can drive impactful climate action while ensuring equity and scalability.

3.6 Building certification systems

Voluntary green building standards and certifications are an important information policy lever to support the elimination of both operational and embodied carbon emissions across a building's life cycle. Voluntary green building standards and certifications can also act to further supplement building codes to serve as 'stretch codes' that go beyond model code decarbonization and provide additional enforcement or validation mechanisms to further strengthen code enforcement processes. The standards and certification programmes also serve to normalize advanced design and construction practices so that cost premiums for advanced construction may be reduced, and voluntary practices may be adopted in future model code update cycles as mandatory.

As part of the GBCT, thirteen certification schemes are monitored (BEAM Plus, BREEAM, CASBEE, DGNB, EDGE, GREEN STAR, GRIHA, LEED, Miljobyggnad, MINERGIE, Passive House, Saaf and WELL). They vary from local certification schemes operating in one country to those operating in 180 countries.

The most recent data available shows that seven of these certification schemes presented a reduction in the annual number of certifications in comparison to 2022. For five of them, the growth from 2022 to 2023 was less than half compared to the growth observed from 2021 to 2022. Only two of the schemes experienced a comparable growth to the previous year or higher.

Certification schemes are more frequently including LCAs and zero-carbon emission principles within their evaluations (IEA *et al.* 2022). Where national definitions of resilient and/or zero-emission buildings are available, certification schemes should align with those existing definitions to contribute to developing a more cohesive market. Certification programmes may be leveraged as a tool to access funding and investment resources, pursuing their alignment for instance with existing finance taxonomies where available. It is also necessary to create incentives at national and international levels to increase transparency, quality and availability of data, particularly when linked to government financing. Even though many of the existing certification schemes are voluntary, having comprehensive and transparent certification information around the world helps build a clearer picture of the status of the building stock in terms of sustainability.

Certification schemes should take into account local contexts and adapt their assessments to promote and support implementation based on regional conditions, particularly in developing countries. Building capacity of subnational governments, educational institutions and certification bodies is key in emerging markets to ensure not only the roll out of certifications but also the quality of the assessments, increasing, therefore, the reliability of the results and reducing risks. In doing this, it is important to consider that the actions should not focus only on increasing the demand for certification, but on increasing the demand in regions where resilient and zero-emission buildings are lacking.

BOX 4. CERTIFICATION SCHEMES MONITORING

Building certifications are an important source of information to have a clear picture of the status of the building stock in terms of sustainability. For this reason, they are one of the indicators monitored in the GBCT (see Chapter 5: Global Buildings Climate Tracker). Unfortunately, monitoring voluntary certification schemes is a challenging task due to the limited availability and transparency of the data openly published by building certification entities. A review of 58 schemes managed by World Green Building Council (WorldGBC) members (WorldGBC 2024a) shows that 37 schemes fall into the scope of the GBCT indicator monitoring green certificates. However, in most of the cases, the annual number of certifications issued by the certification scheme is not publicly available. Currently, the GBCT indicator monitors nine of these schemes (along with four branches of BREEAM), covering 32 per cent of the 37 schemes identified. Additionally, four non-WorldGBC schemes—Passive House, Saaf, GRIHA and MINERGIE—are also tracked. The aim within the GBCT is to gradually expand the number of monitored schemes as data becomes available and more projects are certified by emerging schemes. To do this, better reporting practices need to deployed by certification schemes to provide more consistent and transparent data regarding the number of certified buildings.

Photo: Unsplash

Chapter 4 Investment and financing for sustainable and resilient buildings

Achieving net zero carbon and resilient buildings is affected by the intricate interdependencies between policy and financing. Financial barriers, including limited access to affordable finance and high upfront costs, remain significant challenges. Addressing these requires not only innovative financing mechanisms like green bonds, subsidies, blended instruments and risk mitigation tools but also robust policy frameworks that create market demand and reduce investment risk while fostering inclusive access. Mandates such as energy performance standards and embodied carbon regulations are foundational in creating the regulatory framework necessary to incentivize investments and enable the effective deployment of these financial tools.

4.1 Energy efficiency and renewable energy investment in buildings

In 2023, the global buildings sector faced a significant decline in energy efficiency investments, which accounts for both construction of new buildings going above energy code requirements and investment in energy efficiency retrofits, marking a reversal from previous years of steady growth. Investment levels fell by approximately seven per cent, amounting to approximately US$270 billion, compared to the peak of US$290 billion in 2022 (Figure 15) (IEA 2024e). This downturn is primarily attributed to increased borrowing costs and the winding down of key government support programmes, particularly in Europe.

Higher interest rates have played a critical role in dampening investment enthusiasm, as rising borrowing costs made financing new construction and retrofit projects less attractive, reducing the flow of capital into new green construction, building energy efficiency and renewable energy initiatives. Additionally, several major government initiatives that had driven growth in the sector between 2019 and 2022, such as Germany's KfW efficiency programmes and Italy's Superbonus scheme, began winding down in 2023. These programmes had previously fuelled annual investment growth rates of up to 15 per cent, especially in Europe, which had led global advancements in energy efficiency.

In China and Southeast Asia, similar trends emerged, with economic pressures affecting construction timelines and investment activity. To address slowing energy efficiency investments, in 2023, Beijing launched the Incentive Fund for Green Building Development (IFGBD), promoting energy-efficient upgrades and high-performance green buildings (Baker McKenzie 2024). The programme offers subsidies up to CNY 60 (US$8.25) per square metre for retrofits achieving 2-Star or higher rating under the Green Renovation of Existing Buildings Evaluation Standard, near-zero energy buildings and 3-Star rated new constructions.

In 2023, the Australian Federal budget included AUD 1.3 billion for spending on building energy efficiency through the Clean Energy Finance Corporation (CEFC). The CEFC includes funding for the AUD one billion Household Energy Upgrades Fund (HEUF) to enhance energy efficiency and reduce emissions in Australian homes, targeting over 110,000 households. It also includes AUD 300 million for upgrading social housing. The fund collaborates with financial institutions to provide discounted loans for sustainable home improvements, including solar PV systems, efficient appliances, insulation and electric vehicle chargers. The fund collaborates with financial institutions to provide discounted loans for sustainable home improvements and to support lower interest rates, including reductions of up to 2.74 per cent on home energy retrofit loans. Homeowners can use these programmes for improvements and upgrades such as solar PV systems, efficient appliances, insulation and electric vehicle chargers.

In February 2023, South Africa introduced renewable energy tax incentives designed to bolster energy efficiency and expand the adoption of renewable technologies (South Africa 2023; South Africa Tax Guide 2023). Businesses implementing renewable energy systems could claim a 125 per cent tax deduction on qualifying capital expenditure, while individual households installing rooftop solar panels were offered a rebate of 25 per cent of the installation cost, capped at R15,000 per system. Though primarily aimed at addressing the country's persistent energy shortages and encouraging sustainable practices, these measures highlight the potential role of fiscal incentives in driving energy transitions in Africa. Similarly, Botswana's Rooftop Solar Initiative, launched in 2020, is a net-metering programme enabling households, businesses and industries to install solar PV systems and sell surplus energy to the national grid. The programme is targeting 10 MW capacity, two MW for residential users and eight MW for commercial sectors, and aims to promote renewable energy adoption and reducing reliance on coal and imported electricity.

Despite these and similar efforts across all world regions, in 2023, only four per cent of the total global investment in building construction was directed towards green and energy-efficient projects (IEA 2024e). Furthermore, as economic conditions continue to put pressure on financing, projections for 2024 indicate a further decline, with global investment levels potentially falling to US$260 billion (Figure 15). The outlook beyond 2024 indicates continued challenges in the buildings sector, with persistent pressures from high financing costs and reduced government support expected to drive further declines in energy efficiency investments. Without targeted interventions, these trends could hinder progress towards sustainable building practices.

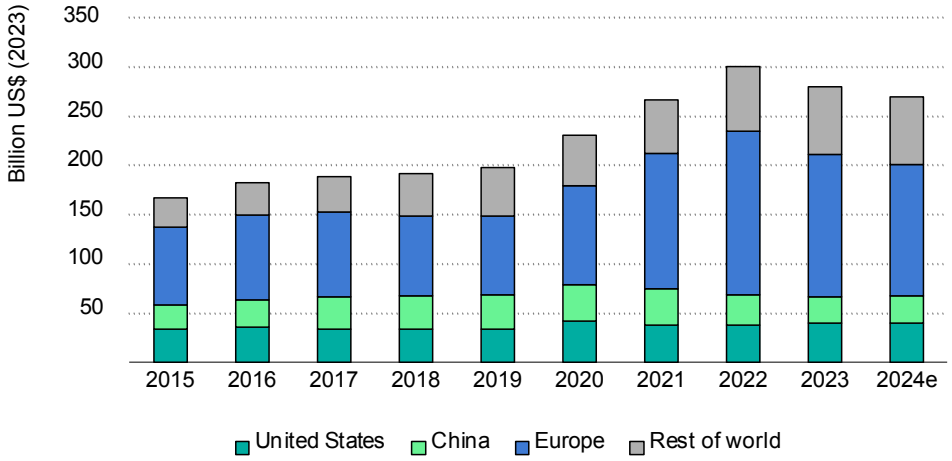

Figure 15. Investment in energy efficiency in buildings and construction (Source: IEA 2024c)

Addressing the decline in energy efficiency investments will require renewed commitment and strategic action from governments and industry stakeholders. Key measures include revitalizing public funding schemes that prioritize energy efficiency and introducing new or enhanced programmes to stimulate investment. Encouraging greater private sector participation, through market incentives that attract investment into energy-efficient technologies and construction practices, is also essential. Additionally, policies that facilitate access to financing by reducing borrowing costs, such as Australia's HEUF, or providing direct financial assistance for energy-efficient projects, such as China's IFGBD, will be crucial in mitigating the current investment downturn. Inclusive finance instruments, such as pooled financing or microcredit schemes, can further address the barriers small borrowers in emerging and developing economies face in accessing funding. These approaches are essential to facilitate broader participation in energy-efficient initiatives and support equitable investment in the energy transition.

The decline in investment underscores the urgent need for a coordinated response to overcome economic barriers and stimulate growth in the sector. According to UNEP's Emissions Gap Report 2024 (2024a), annual investments of US$1.3 trillion to US$2.1 trillion will be required by 2035 to achieve necessary energy efficiency improvements. This funding will focus heavily on retrofits and new construction, alongside upgrades to heating, ventilation, air

conditioning systems, water heaters and cooking technologies. Enhanced investment is vital for advancing global climate goals and transitioning to a sustainable, resilient building stock.

BOX 5. NATIONAL EXAMPLES OF FINANCING FOR ENERGY-EFFICIENT BUILDINGS

United States of America

Efforts to decarbonize the United States of America buildings sector, which accounts for roughly 13 per cent of national GHG emissions, are gaining momentum through federal and state collaboration. Previously announced programmes and policies focus on energy efficiency, electrification and innovative design to reduce emissions, lower energy costs and enhance indoor air quality. Federal funding plays a pivotal role, with significant allocations such as US$90 million from the Bipartisan Infrastructure Law and US$1 billion from the Inflation Reduction Act (IRA) to support zero energy codes and upgrading existing buildings. Additionally, the IRA provides US$8.8 billion for home energy rebates, US$4.5 billion for water heating upgrades, and US$837.5 million for the United States Department of Housing and Urban Development's Green and Resilient Retrofit Program.

States are leveraging these resources to implement transformative policies. Notable initiatives include New York's statewide ban on fossil fuels in new buildings under zero energy codes and Maryland's leadership in the Department of Energy's Better Climate Challenge, targeting a 50 per cent reduction in GHG emissions within 10 years. Utility benchmarking legislation in Colorado mandates utility-provided energy data to improve building efficiency, while Vermont has introduced performance standards to advance clean heating options. Furthermore, the federal Energy Efficiency Home Credit allocates US$4.3 billion to promote passive house construction, achieving up to 90 per cent reductions in heating and cooling energy use.

Germany

The German Federal Ministry for Economic Affairs and Climate Action (BMWK) has introduced a new funding scheme, effective from 1 January 2024, to promote climate-friendly heating systems and improve energy efficiency in buildings as part of the country's broader strategy to reduce GHG emissions and transition to sustainable energy solutions (Germany, Federal Ministry for Economic Affairs and Climate Action 2024). The scheme provides a base funding rate of 30 per cent for renewable energy-based heating systems, including connection costs to heating networks This is supplemented by a 20 per cent "climate speed bonus" for replacing inefficient systems until 31 December 2028, which will gradually decrease by three per cent every two years. An additional income-based bonus of 39 per cent is available for households with taxable incomes below EUR40,000, enabling eligible homeowners to receive up to 70 per cent in total grants. Maximum eligible expenditures are set at EUR30,000 for the first housing unit, EUR15,000 for the second to sixth units, and EUR8,000 for additional units for heating system replacements. Energy efficiency measures such as insulation or window upgrades are eligible for grants up to 20 per cent, with a maximum expenditure of EUR60,000 per housing unit if supported by an individual renovation roadmap. Applications for heating system funding must be submitted to the Reconstruction Loan Corporation (KfW), while other efficiency-related measures are handled by the Federal Office for Economic Affairs and Export Control, with KfW beginning application acceptance on 27 February 2024. The initiative represents a significant advancement in Germany's efforts to enhance energy performance in buildings and aligns with global climate action goals by offering comprehensive financial incentives that facilitate the adoption of renewable technologies and energy-efficient measures within the built environment.

Kazakhstan

Renovating Kazakhstan's building stock presents both a challenge and an opportunity for sustainable economic growth. Current government funding for Net Zero Carbon Buildings is limited to KZT 10 billion (US$22.5 million) (Cities Climate Finance Leadership Alliance [CCFLA] 2024a), distributed through the State Thermal Modernization Program. To align with net zero goals, the World Bank suggests that the government of Kazakhstan allocates 0.7 per cent of its annual GDP, or US$1.35 billion per year, which would cover half of the anticipated transition costs. In response, Kazakhstan approved its first green taxonomy in 2021, and by 2023, green finance had reached KZT 150.2 billion (US$334.4 million). Despite these efforts, challenges remain, notably the underdevelopment of a green bonds market specific to the buildings sector and the lack of targeted financial products for private sector engagement, such as sustainability-linked bonds for developers.

In a bid to stimulate the net zero carbon buildings market, Otbasy Bank introduced Kazakhstan's first green mortgage in 2023 (CCFLA 2024a), allocating KZT 10 billion (US$22.5 million) to support individuals purchasing primary housing that meets recognized green standards like OMIR, BREEAM and LEED. The OMIR standard, developed with international and local expertise, assesses buildings on criteria aligned with net zero goals, covering aspects from energy use to waste management. This initiative marks a significant step towards fostering a sustainable buildings sector in Kazakhstan.

Indonesia

The Indonesia Green and Affordable Housing Program, supported by the International Finance Corporation (IFC), represents a significant initiative to advance sustainable residential construction across Indonesia. This programme aimed to certify 10,000 new green housing units across the populous islands of Sumatra, Java and Sulawesi by 2024, under the Excellence in Design for Greater Efficiencies (EDGE) framework (Trisaputra Zuna 2023). The initiative prioritizes renewable energy integration, energy efficiency and waste management practices in residential buildings. It provides technical assistance grants for assessing climatic conditions, typical building usage patterns and sustainable technology options to demonstrate potential energy and water savings. By subsidizing assessment costs, the programme facilitates green certification and identifies financing needs for green projects. Despite its achievements, challenges remain, such as enhancing data accuracy for performance evaluations and increasing awareness among stakeholders about the availability and benefits of such grants. This programme underscores the importance of aligning affordability with sustainability to address Indonesia's growing housing needs while reducing environmental impacts.

4.2 Banking for energy efficiency and zero-carbon buildings

The global banking sector is increasingly embracing net zero commitments as an essential strategy to combat climate change. As of 2023, 43 banks globally had established sector-specific targets for real estate emissions reductions, compared to 23 banks in 2022 (UNEP 2024b). Most of these targets (56 per cent) focus exclusively on lending portfolios, with a smaller proportion (19 per cent) integrating lending, investment and capital markets activities. European banks are leading the charge, accounting for over half of the target-setting institutions. African lenders are leading in this global shift as well, with South Africa's Nedbank aiming for 100 per cent of its lending and investing activities to support a net zero carbon economy by 2050.

A growing number of banks are actively supporting net zero buildings by setting emissions reduction targets for their real estate portfolios, incorporating science-based benchmarks and adopting metrics such as absolute emissions and intensity measures (e.g., CO_2e per square metre) (UNEP 2024b). They are improving data collection frameworks, leveraging tools like Energy Performance Certificates and the Carbon Risk Real Estate Monitor, and fostering borrower engagement through green financing structures such as sustainability-linked loans.

However, to enhance the effectiveness of funding and ensure it is targeted at the right projects, banks must lay the foundation for effective action and informed decision-making by addressing data gaps, particularly for embodied emissions; standardizing reporting practices across jurisdictions; and enhancing collaboration with policymakers, real estate companies and data providers. Increased focus on retrofitting older buildings, adopting innovative green technologies and setting transparent, inclusive benchmarks calibrated to portfolio characteristics are essential next steps in advancing decarbonization efforts.

4.3 Energy efficiency financing in cities

Urban areas, home to well over half of the global population and the majority of the world's buildings, are critical in the fight against climate change through their governance and practical role in city planning and building regulation. In 2023, 75 per cent of the cities surveyed by the Climate Disclosure Project in their climate finance snapshot cited securing financing for buildings and energy efficiency as a major area of interest, particularly in advanced economies (Climate Disclosure Project 2023). Building up to 2023, the Cities Climate Finance Leadership Alliance (CCFLA) estimates that cities will need around US$1 trillion per year for green retrofits and new construction, and investment in energy-efficient building energy service systems (CCFLA 2024b).

Recent CCFLA analysis of urban climate financing showed financial flows reached US$831 billion in 2021/22 (see Figure 16). Expenditure in green buildings and appliances, at US$234 billion, accounted for 28 per cent of this expenditure (see Figure 16), and represented an increase of around 74 per cent since 2017/18 (CCFLA 2024b). In 2021/22, public financing towards the buildings and construction sector reached US$54 billion from domestic sources. Private financing for this period was around US$120 billion, with most coming from and investing in advanced economies. Though urban climate finance expenditures in the buildings sector have largely focused on energy efficiency in retrofits (US$68 billion) and new construction (US$29 billion), significant sums have also been invested in energy-efficient appliances and lighting (US$58 billion).

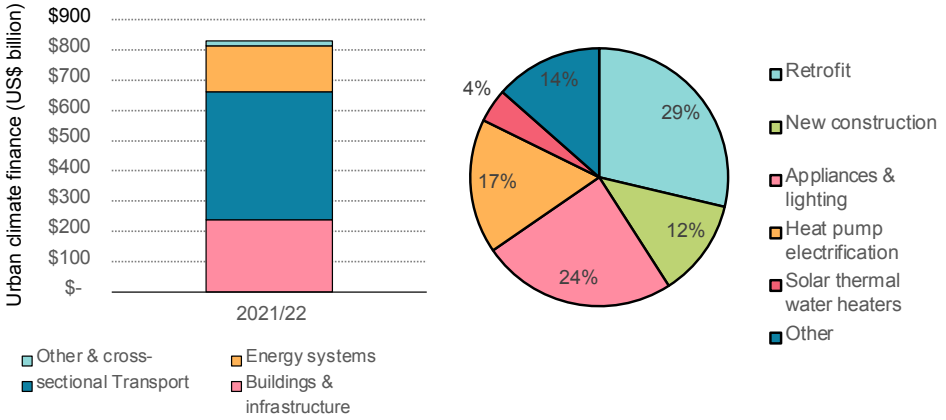

Figure 16. Urban climate finance in 2021/2022 (CCFLA 2024b)

BOX 6. FINANCING INSTRUMENTS FOR SUSTAINABLE CONSTRUCTION

The IFC report *Building Green: Sustainable Construction in Emerging Markets* (2023) identifies several financing options critical to decarbonizing and enhancing energy efficiency in the buildings sector, particularly in emerging markets. They include:

Green bonds are a key financial tool for decarbonizing the construction sector, primarily used to fund projects such as energy-efficient buildings, renewable energy systems and retrofitting existing structures. These bonds attract significant capital due to their strong alignment with sustainability objectives, and they provide scalable solutions for large-scale sustainable construction initiatives globally.

Sustainability-linked debt represents a performance-based financing approach where loans and bonds are tied to specific environmental or sustainability outcomes. These instruments incentivize organizations to achieve emissions reduction and energy efficiency targets while aligning financial and environmental performance.

Green mortgages encourage the construction and purchase of energy-efficient residential properties by offering financial incentives such as lower interest rates. These instruments help drive consumer demand for sustainable housing and support the reduction of the residential construction sector's environmental footprint.

Performance contracts and leasing allow energy service companies or utilities to finance retrofitting projects, eliminating the need for upfront costs for building owners. Investment costs are recouped through energy savings over time, expanding access to energy efficiency improvements across the construction sector.

Real Estate Investment Trusts (REITs), particularly green REITs, offer a growing equity financing tool for sustainable construction projects. These trusts pool investor resources to fund environmentally sustainable real estate developments and have the potential to significantly scale financing for green construction.

Concessional and blended finance provided by development finance institutions plays a vital role in de-risking investments and attracting private sector participation in green construction. These mechanisms leverage concessional terms or combine public and private financing to facilitate projects that might otherwise face financial barriers.

Carbon transition bonds and retirement portfolios present innovative financing mechanisms aimed at phasing out high-emission construction assets and supporting the adoption of green alternatives. These instruments address the need to transition from fossil-fuel-dependent facilities to sustainable construction practices.

These financial instruments support investment stakeholders to transition toward energy-efficient and sustainable building practices through increased investment in energy-efficient refurbishment and construction of green buildings.

4.4 Green bond financing for efficient and sustainable buildings

Green bond financing for buildings has demonstrated remarkable resilience amid global economic pressures such as inflation and high interest rates. In 2023, while green bond issuances for general environmental purposes declined, those targeting green buildings remained stable, buoyed by sovereign and public sector issuers like Fannie Mae in the United States of America and KfW in Germany (see Figure 17). Private institutions and utilities have also entered the market, though concerns persist about the pace and scale at which these funds are being deployed for essential retrofits. In the United States of America, for example, green bond issuance to the buildings sector in 2021 amounted to around US$149 billion, but comprised less than one per cent of the 63.6 trillion issued to the buildings sector as a whole (Ades *et al.* 2024). In Europe, green bond issuance has been strengthened with the adoption of Regulation (EU) 2023/2631, establishing the European Green Bond Standard. This regulation sets uniform requirements for issuers using the 'European green bond' designation, ensuring alignment with the European Union taxonomy for sustainable activities (European Council 2023).

Despite stability in green bond financing, global investment in energy-efficient and electrified buildings faces challenges. Declines in long-term mortgage activities in regions like the United States of America and Europe have constrained renovation financing, as retrofits are largely dependent on homeowners' equity. To counter this, governments and financial institutions are experimenting with mechanisms like green mortgages, zero-interest loans and innovative programmes such as the United States of America's Property Assessed Clean Energy, which ties renovation costs to property value, though such programmes need to be designed to encourage market participation and support equitable access to financing.

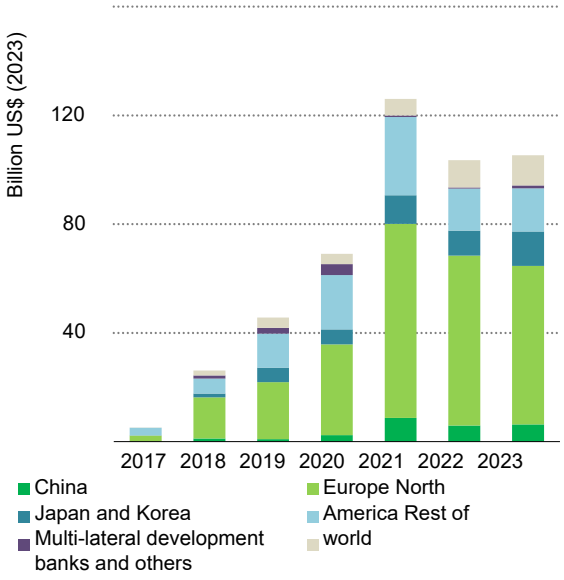

Figure 17. Sustainable debt issuance for green buildings (IEA 2024e)

For emerging markets, the financial landscape for green construction remains underdeveloped. Global private green debt financing for construction reached US$230 billion in 2021, however, only 10 per cent of this was issued from emerging markets (IFC 2023). The challenges that emerging markets face include underdeveloped financial and insurance markets, inadequate regulatory mechanisms, limited access to green technologies, reliance on carbon-intensive construction materials and methods and knowledge and capacity gaps, the impacts of which are exacerbated by an increasing demand for buildings driven by population growth and rising incomes.

Given these challenges, global construction emissions are expected to rise by 13 per cent from 2022 levels by 2035, with emerging markets accounting for a significant share of this growth (IFC 2023). However, by addressing these barriers and embracing existing and emerging green technologies, investments in energy-efficient materials and sustainable practices, emissions could instead decline by up to 13 per cent, with emerging markets driving 55 per cent of the reduction potential (IFC 2023).

BOX 7. GREEN BONDS IN EMERGING MARKETS

Green, social, sustainability and sustainability-linked bond issuance in emerging markets surged by 45 per cent in 2023, reaching a record US$209 billion (IFC and Amundi Asset Management 2024). According to the IFC, this significant growth was driven by reduced inflationary pressures, proactive government and corporate climate initiatives, and improved financial market conditions that encouraged investment in sustainable projects. Latin America, for example, experienced an almost 90 per cent increase in green bond issuance. In this and other regions, green bonds are becoming a key tool for financing urban development. Cities such as São Paulo, Barranquilla, Mendoza and Mexico City, which have credit ratings to support municipal bonds, are already leveraging this mechanism (Lizon 2023).

In terms of the buildings sector, green buildings took the second largest share with 29 per cent in 2023 (see Figure 18). Recent initiatives such as the global practical guide launched by an international alliance of green certification schemes (Alliance HQE *et al.* 2024) can leverage the momentum of the increase of green bonds in the sector, and facilitate the mobilization of investments required for the transformation of the building stock. The guide details how diverse building rating standards can be used to comply with global classifications and bond frameworks, setting a trajectory for the global built environment to meet a sustainable 1.5°C climate threshold.

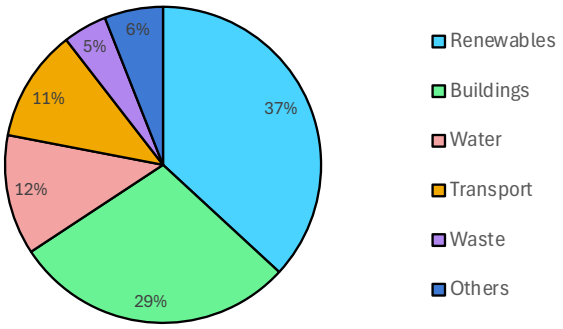

Figure 18. Emerging market green bond issuance by designation of proceeds (International Finance Corporation and Amundi Asset Management 2024)

Photo: Unsplash

Chapter 5 Global Buildings Climate Tracker

The GBCT, first published in 2020, provides a key metric for monitoring the progress towards decarbonizing buildings globally. Through a seven-part composite index, the GBCT offers a snapshot of decarbonization efforts in the buildings sector from 2015, the year the Paris Agreement was established, up to the current year (this edition includes data up to 2023). Continuing from last year's edition, this report evaluates progress against a reference scenario that envisions a fully decarbonized buildings sector by 2050.

As shown in Figure 19, the GBCT combines the CO_2 emissions linked to building operations with six additional indicators to provide a comprehensive view of the sector's decarbonization progress. While the GBCT currently focuses on CO_2 emissions from building operations, it is important to also consider the role of embodied carbon emissions in the buildings sector. However, at present, these emissions are not included in the GBCT due to the absence of a global dataset covering a complete scope of embodied carbon emissions during the full timespan of the tracker.

Four of the indicators track actions taken to advance decarbonization—namely, energy efficiency investments, green building certifications, NDCs considering buildings and building energy codes. The remaining two indicators reflect the impact of these actions, measuring building stock energy intensity and the share of renewable energy in final energy demand. CO_2 emissions serve as a multiplier, while the other six indicators are combined using a weighted sum, as established in the GBCT's initial edition: 63 per cent for action indicators and 37 per cent for impact indicators.

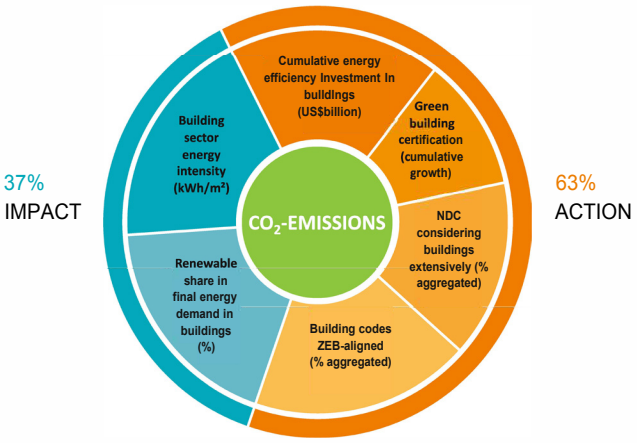

Figure 19. GBCT indicators weights (Source: Building Performance Institute Europe)

In this edition of the GBCT, indicator goals continue to follow the reference scenario established in the previous editions, ensuring alignment with the composite index's final decarbonization goal. Using the IEA's Net Zero Emissions scenario (2023c) as a benchmark, the GBCT defines a 2030 milestone for short-term actions and a 2050 target for full decarbonization. The only methodological adjustment involves the renewable share in final energy demand within buildings, which is now refined to capture both direct renewable energy use in buildings and the share of electricity provided by renewable sources. The Annex provides a comprehensive outline of these methodology and goal adjustments.

Figure 20 (left) shows the reference decarbonization path for the buildings sector from 2015 to 2050. This path is derived by combining the reference paths of the seven indicators. For each indicator, a linear progression is assumed, moving from the starting point in 2015 to the 2030 milestone, and then towards the 2050 target. The reference paths of the indicators are aggregated using a weighted sum, as outlined earlier, and are subsequently multiplied by the CO2 emissions indicator.

Figure 20 (right) zooms in to present the period 2015–2023. The latest data show that the decarbonization of the buildings sector continues to be far off track. Over the last seven years, the decarbonization index fluctuated, with a marked increase in 2020 (reaching 5.4 points), followed by a significant decrease in 2021 (dropping to 1.0 point). Encouragingly, the index resumed its upward trajectory the following year, recording an improvement of 2.8 points in the decarbonization index in 2023. Nevertheless, the pace of increase recorded over the past two years remains significantly below the trajectory required to achieve the 2030 and 2050 decarbonization targets. As Figure 20 (right) shows, the gap has been consistently growing, from 25.8 decarbonization points in 2020 to 44.3 decarbonization points in 2023, which is indicative of a global stagnation in buildings-related climate mitigation action. This underscores the need for a systemic effort and a paradigm shift to mobilise action and align the sector with its decarbonization goals. Note that the results from the previous editions of the GBCT differ from the results presented in this report due to the changes implemented in the methodology and goals of some of the indicators. For more details please refer to the Annex.

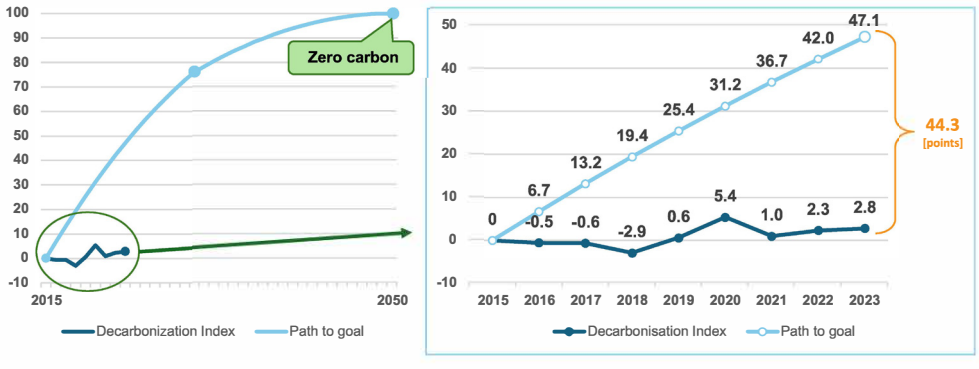

Figure 20. GBCT decarbonization index. Left: reference path until 2050. Right: zoom in for the 2015 –2023 period. (Source: Building Performance Institute Europe)

The nature of the challenge is made clearer by exploring the indicators that make up the GBCT in finer detail. Table 3 provides a summary of select indicators, showing values from the index starting in 2015 and the corresponding values for 2023.

Table 3. GBCT indicators observations summary, 2015–2023

Indicator	Starting value in 2015	Observed value in 2023	Observed change from 2015 to 2023	Necessary change from 2015 to 2023	Indicator status
Emissions					
Buildings sector energy-related emissions	9.3 [$GtCO_2$/ year]	9.8 [$GtCO_2$/ year]	+5.4 [per cent]	-28.1 [per cent]	
Impact					
Buildings sector energy intensity*	146 [kWh/ m²]	132.2 [kWh/ m²]	-9.5 [per cent]	-18.2 [per cent]	
Renewable share in final energy demand in buildings**	13 [per cent]	17.5 [per cent]	+4.5 percentage points	+17.8 percentage points	
Action					
Cumulative energy efficiency investment in buildings	161.5 [US$bn]	1936.2 [US$bn]	+1,774.7 [US$bn]	+2,897.3 [US$bn]	
Green building certification (cumulative growth)	1.0 points	10.8 points	+9.8 points	+17.5 points	
NDC considering buildings extensively (aggregated)	0.7 [per cent]	6.3 [per cent]	+5.7 percentage points	+39.6 percentage points	
Building codes ZEB-aligned (aggregated)	0 [per cent]	2.2 [per cent]***	+2.2 percentage points	+40.0 percentage points	

* The IEA updated the data for this indicator for the full period of observations, therefore, data for 2015 and later years is slightlydifferent from the data presented in previous editions.

** The methodology for this indicator was refined to include not only renewable energy directly used in buildings but also an estimation of the portion of electricity provided by renewable sources. See Annex.

*** In the previous edition, France was counted within the countries with zero emissions building-aligned building codes. While France has in place a requirement for zero emissions buildings, the adopted code requires a 52 per cent reduction in emissions from 2022 levels but has not yet the obligation for net zero emissions in the official code.

GBCT figures for 2023 indicate that CO_2 emissions from building operations have not decreased since 2015. Rather, emissions have increased by 5.4 per cent compared to the 2015 levels, contrary to the needed reduction of 28.1 per cent. Furthermore, indicators measuring the impact of decarbonization efforts show limited progress. The energy intensity of buildings recorded a 9.5 per cent decrease, well short of the required 18.2 per cent reduction. Additionally, the share of renewable energy in buildings' final energy demand grew by just 4.5 percentage points, far below the 17.8 percentage points needed.

In terms of actions taken towards decarbonization, the GBCT reveals that the cumulative energy efficiency investments in buildings from 2015 to 2023, while not insignificant, was US$1.123 trillion less than required to stay on track. Green building certifications, which have increased by 9.8 points, are still 7.7 points below the necessary value. Regarding policy progress, as of 2023, only 19 countries had included detailed buildings sector plans in their NDCs, and only two countries had building energy codes aligned with zero energy building principles. Although this represents some progress, these two indicators, at 6.3 per cent and 2.2 per cent respectively, remain far below the levels required to keep the sector on track. Note

that the number of countries is not translated directly into percentages for these two indicators. Here it is considered that advanced economies may reach net zero emissions in advance of others, i.e. by 2030 all G20 members and 50 per cent of the remaining countries should include a detailed strategy for the buildings sector within their NDCs and have building energy codes including ZEB principles. For more details on the methodology for these two indicators please refer to the Annex.

The limited progress, and in some cases worsening, observed in the GBCT indicators accounts for the considerable gap shown in Figure 20 between the current decarbonization status of the building stock and the reference path. Figure 21 presents a pathway to realign with the target by the end of the decade, moving towards the long-term 2050 goal (to enhance clarity, the reference path is shown only up to 2030 in the figure).

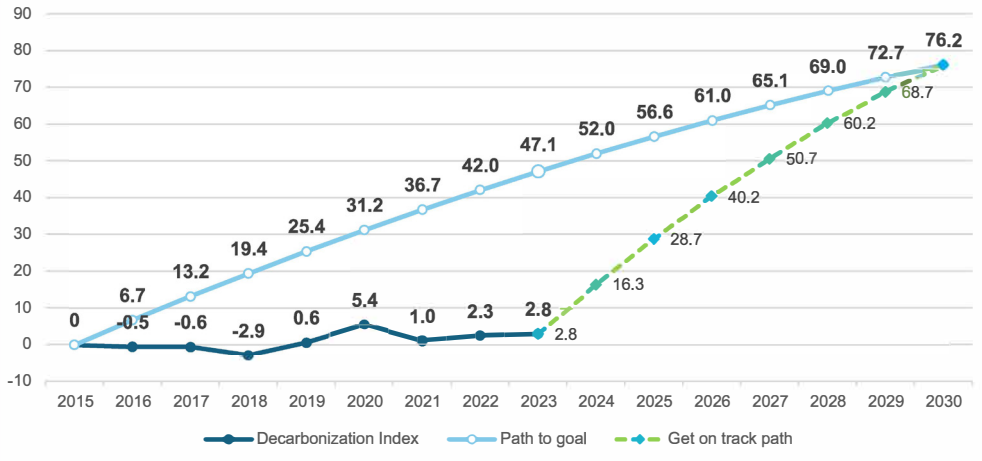

Figure 21. GBCT observations and path to get on track by 2030. (Source: Building Performance Institute Europe)

In 2015, staying on track with the reference path required an average decarbonization of around six points per year. However, due to insufficient progress up until 2022, the gap between the reference and actual trajectories has widened. Accordingly, approximately ten decarbonization points are needed annually to make up for lost ground and get back on track to achieve the 2030 target.

To effectively get back on track towards the 2050 goal, it is essential to not only accelerate the implementation of impactful measures across all areas covered by the GBCT indicators but also to strengthen the mechanisms for monitoring, reporting and verifying these actions. This dual approach will ensure that progress is both measurable and aligned with the decarbonization targets. In the following section, this report delves deeper into the development of the indicators, examining the gaps in progress up until 2023, and highlighting the key opportunities for realigning efforts to meet the 2030 and 2050 objectives.

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Chapter 6 Buildings climate policy gap review

The slow progress in the decarbonization of the global building stock, evidenced by the GBCT, is the result of gaps in progress across the monitored indicators. This section identifies actions needed to address the gaps observed in the reduction of emissions and the progress on impact and action indicators.

The GBCT established a reference path in 2015, the year of the signing of the Paris Agreement, which requires certain levels of progress on each of its component indicators in order to achieve a net zero built environment by 2050. However, as a result of the limited progress recorded up to 2023, additional actions will now be required across all indicators to get the buildings sector back on track by 2030 and realigned with the reference path. Table 4 compares the progress (average annual increase or decrease) that would have been required annually during 2015–2023 to stay on the reference path against observed developments during the same period. The table also presents the progress that is now required annually to bring the decarbonization of the buildings sector back on track by 2030. Figure 23 illustrates the concept based on the CO_2 emissions indicator.

Table 4. GBCT indicators required efforts to get on track by 2030

Indicator	What was the annual progress required from 2015?*	What was the annual progress observed in the 2015–2023 period?**	What is now required annually to get on track by 2030?***
Emissions			
Buildings sector energy-related emissions	↓ 0.33 [$GtCO_2$/year] (↓ 4 per cent per year)	↑ 0.06 [$GtCO_2$/year] (↑0.7 per cent per year)	↓ 0.77 [$GtCO_2$/year] (↓10.8 per cent per year)
Impact			
Buildings sector energy intensity	↓ 3.3 [kWh/m²] (↓ 2.5 per cent per year)	↓ 1.7 [kWh/m²] (↓ 1.2 per cent per year)	↓ 5.1 [kWh/m²] (↓ 4.4 per cent per year)
Renewable share in final energy demand in buildings	↑ 2.2 percentage points	↑0.6 percentage points	↑ 4.1 percentage points
Action			
Cumulative energy efficiency investment in buildings****	↑ 362.2 [US$bn]	↑ 221.8 [US$bn]	↑ 522.5 [US$bn]
Green building certification (cumulative growth)	↑ 2.2 points	↑ 1.2 points	↑ 3.3 points
NDC considering buildings extensively (aggregated)	↑ 5 percentage points	↑ 0.7 percentage points	↑ 9.8 percentage points
Building codes ZEB-aligned (aggregated)	↑ 5 percentage points	↑ 0.3 percentage points	↑ 10.4 percentage points

* Average annual progress required at the beginning of the reference path in 2015

** Average annual development observed during the 2015–2023 period

*** Average annual progress required after 2023 to get on track by 2030

**** Here the figures correspond to the annual values that derive to the cumulative investment

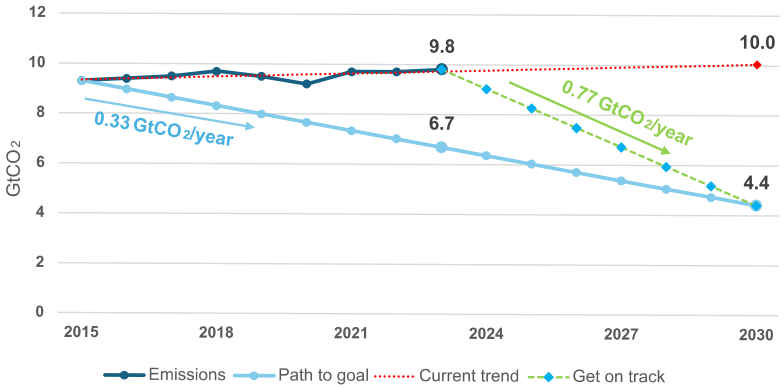

Figure 22. CO_2 emissions path to get on track by 2030 (Source: Building Performance Institute Europe and adaptation based on IEA data)

6.1 Emissions

Based on the current situation, direct and indirect CO_2 emissions resulting from the operation of buildings need to decrease on average by 0.77 $GtCO_2$ (around 10.8 per cent every year) to get back on track and reach the interim target of 4.4 $GtCO_2$/year in 2030.

To achieve this more ambitious requirement, countries should deploy a tailored policy mix combining effective measures, including equity and gender-responsive policies that address the unique needs and contributions of marginalized groups and women in the buildings sector. In its global monitoring of policies for decarbonization of buildings (OECD 2024b), the OECD recommends developing a tailored step-by-step roadmap, with clear milestones and timelines, and robust monitoring and support mechanisms. Experiences gathered from 41 countries over a period of 24 years (Stechemesser *et al.* 2024) show that a combination of different policy instruments such as bans, building codes, energy efficiency mandates and subsidies are more effective than rolling out a standalone approach. These decarbonization instruments should be complemented with and linked to resilience measures to ensure that buildings are not only reducing the CO_2 emissions they produce but also remain resilient to increasing climate risks.

Even though the GBCT does not monitor embodied emissions, the reduction of the operational emissions cannot happen in isolation because actions to lower operational carbon can inadvertently increase embodied carbon. A whole life cycle approach that addresses these linkages and prioritizes circularity of construction materials and components is therefore essential. In this regard, international cooperation to map existing best-in-class projects and measuring frameworks is crucial (GlobalABC *et al.* 2024). This will help develop more standardized frameworks outlining the scope of the emissions, and quantification and assessment strategies.

6.2 Tracker policy impact

The two impact indicators—buildings sector energy intensity and renewable share in final energy demand in buildings—similarly require a scaling up of action to get the sector back on track. Based on the current situation, buildings sector energy intensity needs to reduce on average by 5.1 kWh/m² (around 4.4 per cent) every year until 2030 to achieve the 96.2 kWh/m² target for that year. This reduction does not only contribute to climate goals but also enhances living conditions, particularly for women, who often spend more time in residential buildings and are disproportionately affected by poor indoor air quality (Okello *et al.* 2018; Dwivedi *et al.* 2023). This level of progress will require energy intensity to decrease roughly three times faster than the rate observed up to 2023.

Integrating energy efficiency principles in building energy codes and deploying minimum energy performance standards are key tools for reducing the energy use intensity of new and existing buildings. Regarding minimum energy performance standards, previous experiences show that it is important to roll out these schemes with incremental regulations and clear roadmaps to allow businesses, communities and markets time to prepare and adapt (OECD 2024b).

Building energy intensity is also influenced by how efficiently built spaces are utilized, with an increase in floor area potentially contributing to higher embodied carbon emissions, even if the new spaces are less energy intensive. In this context, it is important that efforts in established markets focus on the adaptation and repurposing of existing buildings, reactivating vacant buildings and the equitable and smart use of built spaces in existing and new buildings. In emerging economies, building floor areas and energy consumption will need to increase to reduce overcrowding, increase the quality of living spaces and provide safe and adequate housing for people living in informal settlements. In these regions, it is crucial to put regulations in place and build enforcement capacity to ensure that this rapid expansion of the building stock is grounded in highly energy-efficient building principles.

Additionally, the renewable share in final energy demand in buildings needs to increase on average by 4.1 percentage points until 2030 to reach the 46.4 per cent target in that year. This level of annual progress will require the renewable share to increase at almost seven times the rate observed until 2023. However, as of 2023, only 90 countries had a national renewable energy target (REN21 2024b). Setting national renewable targets and developing clear roadmaps will thus be crucial to stimulating market activity, and giving investors, businesses and other stakeholders more certainty about the current and future demand for renewable energy.

Building codes can be used to drive further progress by including minimum requirements for the share of renewable building energy in the supply for new buildings and deep renovations. To maintain policy coherence, countries must ensure that this is aligned with the national definitions of near-zero-emission, zero-emission and resilient buildings and that there is the knowledge and capacity to ensure that buildings are constructed or renovated in accordance with the mandated requirements. In terms of renewables for electricity, depending on the circumstances of the country, further acceleration will depend on shorter permit wait times, investments in grid infrastructure and policies to increase flexibility and the phase out of fossil fuels, and to facilitate off-grid solutions (aligned with grid expansion plans) and policies to ensure a people-centred and fair transition (IEA 2024f). For heating and cooling, a clear road map for the phase out of fossil fuel technologies is required. District heating decarbonization potential remains untapped outside Europe (IEA 2024g). In this regard, district systems offer significant untapped potential for the decarbonization of the heating and cooling supply. Unlocking the potential of this technology, which remains largely untapped outside Europe, is important to achieving 2030 and 2050 decarbonization targets.

Lastly, the deployment of renewable energy systems needs to be integrated with the implementation of energy efficiency principles to optimize overall effectiveness. Reducing energy demand from buildings not only helps to lower emissions from energy use but also ensures renewable energy systems function more smoothly and efficiently, supporting the overall stability and performance of the energy infrastructure (Petrichenko and Vautrin 2024).

6.3 Tracker policy action

In terms of the action indicators, the rate of progress to increase the energy efficiency investment in buildings, green building certifications, ZEB-aligned building codes and NDCs considering buildings extensively also needs to be accelerated.

The cumulative investments in energy efficiency in the buildings sector need to increase, on average by US$522.5 billion annually until 2030, more than double the average annual investments observed up to 2023. Achieving this will require the collection of better data on these investments, including sources (e.g. private, public), target groups (e.g. vulnerable groups, worst-performing buildings, new and existing social housing) and types of instruments (e.g. loan, grants, subsidies). This information will allow national governments to better align policy frameworks with private investor priorities, recognize when further strategies are needed and refine existing investment instruments to maximize environmental and social impact across target groups. Additionally, tracking these mechanisms helps identify the most effective approaches, supporting their replication in other national and international contexts.

Furthermore, strategies are needed to improve the evaluation of investment decisions by integrating externalities and co-benefits into the analyses. Doing so will enable governments, investors and other stakeholders to more comprehensively evaluate the full value of these investments, by accounting not only for energy savings but also for environmental and social benefits. Additionally, it is essential to consider the economic consequences of inaction, which include the opportunity costs of actions required to address impacts of extreme weather events such as floods, droughts and extreme temperatures when making investment decisions. To mobilize more investments, it is also necessary to devise strategies to reduce investment risk. This can be done by facilitating public-private implementation of pilot projects and to increase experience feedback/lessons learned (GlobalABC *et al.* 2024). Setting clear milestones for the implementation of key actions, like updating building codes, ensuring that the capacity to implement and effectively enforce those codes exists, and introducing building performance standards and certificates within national and sub-national roadmaps, can also strengthen policy credibility, enhance enforcement capacity and increase investor confidence in the transition, helping to derisk private investment in the sector (IEA *et al.* 2024). Building performance standards, in particular, can address gaps where energy code enforcement may be lacking by focusing on measurable outcomes, which do not depend on a limited or specialised enforcement workforce.

The cumulative aggregated number of green building certifications needs to increase by 3.3 points per year between now and 2030 to get the sector back on track. Achieving this rate of increase requires a more than doubling of the annual growth rate observed up to 2023. Potential strategies to accelerate growth in green building certifications could include incentives to promote the certification of existing buildings at diverse trigger points (e.g. selling, renovation). This is aligned with the call for scaling up of procurement alliances between the private and public sector made by the Buildings Breakthrough Agenda (GlobalABC *et al.* 2024).

Building energy codes that incorporate ZEB definitions and related emissions limits will need to become more widespread in order to realign the sector with the required decarbonization pathway. As of 2023, only the United States of America and Canada had ZEB-aligned building codes, and both were voluntary. To get the sector back on track, the rest of the G20 (44 countries) and at least 75 additional countries must adopt ZEB-aligned building codes between now and 2030, and ensure that the capacity exists to effectively implement and enforce those codes. This is essential to ensure that all new buildings constructed after 2030 are ZEBs. It is important, however, that these measures are complemented by the incorporation of resilience principles in building codes to ensure that new buildings are constructed based on the climate risks that they are projected to face during their service life rather than based on historical risk. Furthermore, to deliver maximum impact, these definitions and guidelines should not only apply to new buildings but should also be extended to renovations.

To get the buildings sector back on the required decarbonization trajectory, the proportion of NDCs that extensively address buildings must increase by 9.8 percentage points annually through 2030. However, as of 2023, none of the G20 countries extensively cover the buildings sector in their NDCs. Getting the sector back on track to meet the 2030 targets will therefore require all G20 nations and 56 additional countries to adopt extensive building strategies within their commitments. This will entail integrating the preceding recommended measures and other relevant decarbonization strategies into country NDCs to ensure cohesive and effective action.

With NDCs expected to be updated only every five years, and the next update happening in early 2025, the opportunities to address the decarbonization of the buildings sector in a well-timed, cohesive and effective manner are diminishing. The 2025 NDC update cycle therefore represents a pivotal opportunity for countries around the world to take decisive action to include clear actions for the buildings sector. Among others, their NDCs should include energy efficiency considerations and sufficiency principles and must adopt an integrated approach combining mitigation and adaptation strategies as well as capacity-building considerations. To support this effort, the World Green Building Council has announced the development of an NDC scorecard designed to evaluate and strengthen national policies for the built environment (World Green Building Council 2024b). Promoting the integration of NDC processes, increasing data availability and access, building regulatory and stakeholder capacity, and strengthening regional communities will also play a key role in strengthening the treatment of the buildings sector in the next NDC update (IEA *et al.* 2024).

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Chapter 7 Roadmaps for buildings and construction

7.1 Climate action roadmaps for buildings and construction

As countries work to achieve their climate goals and fulfil international commitments, the creation and implementation of comprehensive roadmaps for inclusive buildings sector decarbonization and resilience have become essential. Climate action roadmaps for buildings and construction help to set a pathway with specific actions, a timeline and ambitious targets to reduce operational and embedded carbon emissions from buildings and construction while increasing resilience and improving wellbeing and inclusivity in the sector. These roadmaps serve as strategic frameworks that not only guide national and sub-national efforts but also promote sustainable practices within the built environment. They act as essential tools that facilitate collaboration among diverse stakeholders and set ambitious and concrete targets. These collective actions aim to achieve significant reductions in carbon emissions while fostering more resilient and inclusive communities. Roadmaps can also serve as important signalling tools, providing clarity and confidence to investors and markets by setting out clear policy and regulatory directions. Furthermore, tools that provide clarity and confidence to investors and markets will support setting out clear policy and regulatory directions.

Best practice climate action roadmaps should outline short-, medium- and long-term targets and priorities designed to enhance inclusive climate action, driving decarbonization and resilience in the buildings sector while leaving no one behind. The Human Settlement – Climate Action Pathways report, which sets out practical guideline on how to achieve the Paris Agreement, calls for all countries to develop buildings and construction roadmaps by 2030 (GlobalABC and Local Governments for Sustainability 2021).

This initiative aligns with the principles outlined in the Chaillot Declaration, which underscores the importance of sustainable urban development and collaborative action to combat climate change. As of 2024, GlobalABC has supported the development of 32 roadmaps at regional, national and sub-national levels. Of these, 14 adhere to the GlobalABC methodology, covering key focus areas.

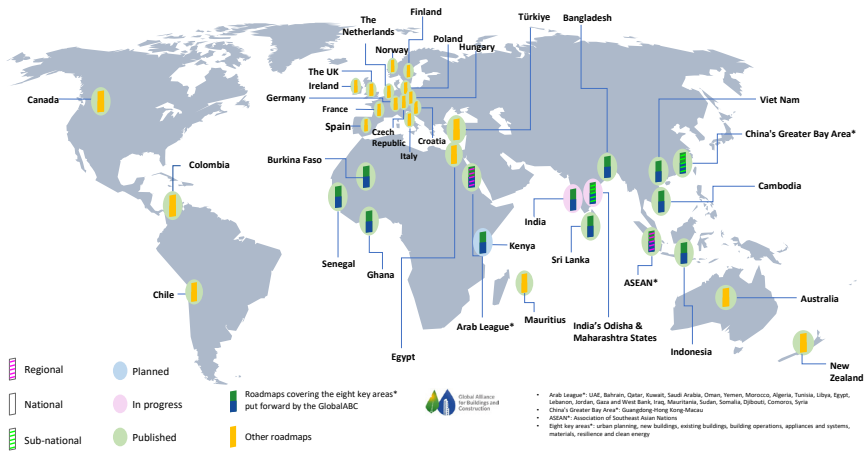

Figure 23. Climate action roadmaps for buildings and construction

Note: Arab League*: United Arab Emirates, Bahrain, Qatar, Kuwait, Saudi Arabia, Oman, Yemen, Morocco, Algeria, Tunisia, Libya, Egypt, Lebanon, Jordan, Gaza and West Bank, Iraq, Mauritania, Sudan, Somalia, Djibouti, Comoros, Syria. China's Greater Bay Area*: Guangdong-Hong Kong-Macau. ASEAN*: Association of Southeast Asian Nations. Eight key areas*: urban planning, new buildings, existing buildings, building operations, appliances and systems, materials, resilience and clean energy.

These roadmaps cover diverse regions and countries, including Senegal, Ghana, Bangladesh, India, Viet Nam, Cambodia, Burkina Faso, China, Sri Lanka and Indonesia as well as broader regional initiatives in Africa, Asia, Latin America and the Arab League.

To support the creation of these roadmaps and facilitate the realization of climate action pathways, GlobalABC has developed a new methodology. This step-by-step guidance builds on lessons learnt and experience accumulated over the past four years by international experts and previous roadmaps. It provides detailed support for setting goals, identifying key actions and creating a pathway towards a more efficient, low-carbon, resilient and inclusive buildings and construction sector. It is a collaborative process that engages stakeholders and facilitates the roadmap development process, helping countries to set and achieve more ambitious building-related targets for their NDCs. In 2024, this methodology was piloted in Ghana, Senegal and Bangladesh by UNEP, the United Nations Office for Project Services (UNOPS) and the United Nations Human Settlements Programme (UN-Habitat), and is being used to develop sub-national roadmaps for the states of Odisha and Maharastra in India. The final guidance document and supporting tools are now available on the GlobalABC website, providing resources to help countries and jurisdictions effectively develop and implement their climate action roadmaps (GlobalABC 2024).

7.2 Guidance for climate action roadmaps

Supported by UNEP, GlobalABC, UNOPS and an international panel of experts, the Guidance for Climate Action Roadmaps in Buildings is a collaborative and step-by-step methodology developed to assist governments in creating climate action roadmaps, effectively translating ambitions into actionable strategies (GlobalABC 2024). The updated GlobalABC framework presents a holistic approach to decarbonization, addressing carbon emissions and resilience across the buildings value chain, while integrating climate adaptation and inclusion as core components. It outlines four primary objectives: 1) Embodied Carbon Reduction, 2) Operational Carbon Reduction, 3) Adaptation, and 4) Wellbeing and Inclusion, aligned with the Paris Agreement and climate action pathways.

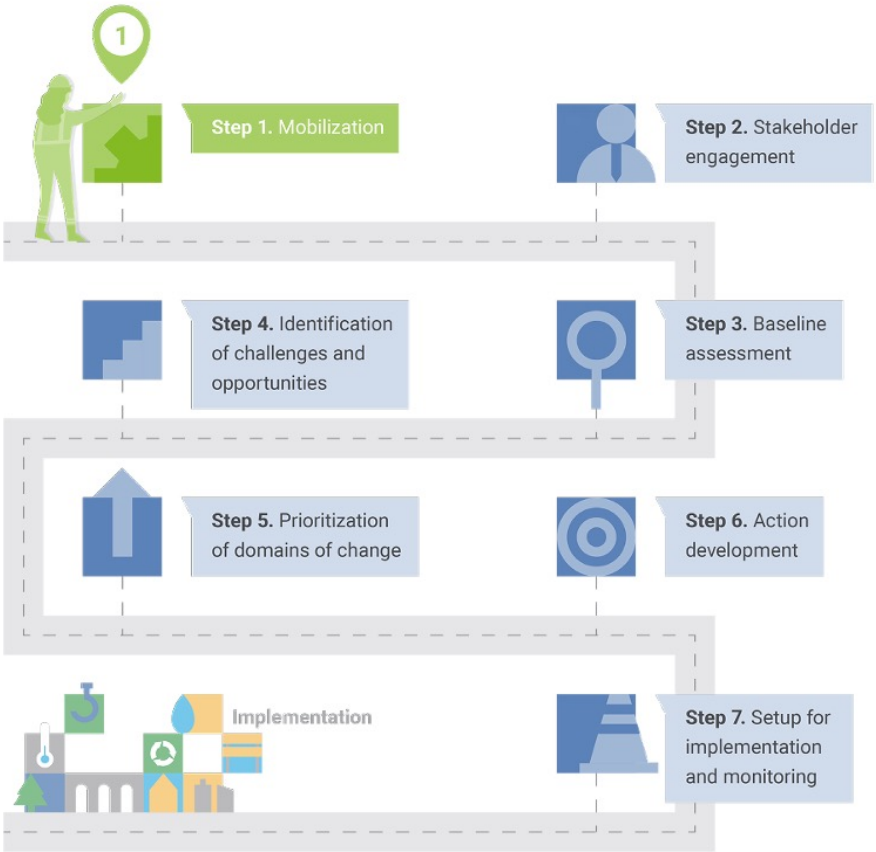

Figure 24. GlobalABC roadmap step-by-step methodology

The framework defines five action areas. Strategic Priorities features inclusive climate action in governance, with clear mandates for ministries and local governments. Spatial and Urban Development addresses the role of land use and urban planning in mitigating emissions and enhancing resilience. New Buildings emphasizes sustainable and inclusive construction practices from design to delivery. Existing Buildings targets reducing operational emissions through maintenance, renovation, and circularity. Construction Supply Chain encompasses the life cycle of materials, promoting upstream improvements and equitable practices. Together, these areas ensure comprehensive climate action across the entire value chain.

The GlobalABC methodology employs a standardized seven-step approach for roadmap development (see Figure 24): 1) Mobilization, defining objectives and forming teams; 2) Stakeholder engagement, strategizing participation; 3) Baseline assessment, identifying sector gaps and opportunities; 4) Identification of challenges and opportunities, drafting problem trees; 5) Prioritization of domains of change, focusing on root-cause analysis; 6) Action development, formulating best practices; and 7) Setup for implementation and monitoring, ensuring a smooth transition from planning to execution with funding and evaluation frameworks.

The guidance adopts a collaborative, step-by-step approach across seven stages—from mobilization and stakeholder engagement to analysing the status of the buildings sector and defining key goals and objectives. This framework empowers governments and stakeholders to set their own targets, develop action plans for implementation, and establish monitoring practices.

The guidance covers a qualitative and quantitative assessment of the buildings sector. It includes: the physical environment (i.e. the buildings); analysis with indicators and metrics to achieve targets in the following years and 2030–2050 strategies and a qualitative assessment; and a rapid questionnaire to be filled in by experts to understand the status.

7.3 National Circularity Assessment Framework for Buildings

As part of the new framework and complementing the GlobalABC methodology, the National Circularity Assessment Framework for Buildings has been developed by GlobalABC, the One Planet Network, UNOPS and UN-Habitat, with funding from Finland's Ministry of Environment. This strategic tool is designed to assist countries in evaluating and enhancing the circularity of their buildings sector. It offers a structured approach for assessing the life cycle impacts of buildings, with three clear objectives: resource efficiency, waste reduction and material reuse. By integrating circular economy principles into building practices, the framework aims to facilitate a transition toward sustainable construction, promote resilience and align with global climate goals. Through comprehensive assessments and active stakeholder engagement, it empowers governments and industry stakeholders to implement effective policies and strategies that drive circularity in the built environment.

7.4 New regional and national roadmaps for buildings and construction following the GlobalABC methodology

7.4.1 The Regional Roadmap for Buildings and Construction in the Arab Region (2020–2025)

The Regional Roadmap for Buildings and Construction in the Arab Region (2020-2025) offers a strategic framework for advancing zero-emission, efficient and resilient buildings across 22 Arab countries (GlobalABC and Dubai Ministry of Energy and Infrastructure 2023). Developed using the GlobalABC methodology and under the initiative of the United Arab Emirates, this roadmap considers the region's unique climate conditions, economic factors, energy profiles and urbanization trends to achieve net zero carbon emissions in the buildings and construction sector by 2050. Its focus includes sustainable building practices and reducing sectoral emissions, with tailored solutions that reflect the diverse environmental and socio-economic contexts within the region. This approach promotes regional collaboration toward a sustainable and climate-resilient built environment. The roadmap outlines strategic priorities, including adopting renewable energy systems, improving energy efficiency, and promoting climate-responsive urban development.

The United Arab Emirates, for example, has implemented the United Arab Emirates Green Building Regulations and Specifications, which mandate energy efficiency and sustainability standards for new buildings and renovations, demonstrating how national-level policies align with the broader goals of the roadmap. Specifically, these regulations target reductions in energy consumption and water use, with mandatory compliance for new developments and major renovations to integrate renewable energy systems and sustainable materials.

7.4.2 Climate Action Roadmap for Buildings and Construction Ghana

The Climate Action Roadmap for Buildings and Construction Ghana supports the national government in transforming the sector towards a low-emission, efficient and resilient built environment (Ghana, Ministry of Works and Housing 2024). Published in November 2024, it aligns with Ghana's NDCs under the Paris Agreement and follows the GlobalABC methodology. The roadmap prioritizes key action areas, including spatial and urban development, new buildings, existing buildings and the construction supply chain.

By 2030, Ghana aims to reduce the annual built expansion rate to two per cent per annum and decrease cities at risk of extreme heat to 20 per cent. For existing buildings, it targets reduced use of cement and metal sheets for retrofitting and public renovations. New buildings aim to cut cement use for outer walls to 60 per cent by 2030 and achieve a 40 per cent reduction in total energy consumption through green building certifications. These targets will progress to stricter reductions by 2040 and 2050, highlighting long-term ambition.

The roadmap emphasizes collaboration with key stakeholders, such as the Ministry of Works and Housing and the Environmental Protection Agency. Additionally, it includes provisions for using low-carbon construction materials in at least 30 per cent of new government buildings by 2030, rising to 70 per cent by 2050. This holistic approach ensures alignment with Ghana's climate goals while addressing challenges like data gaps and technical capacity.

7.4.3 Climate Action Roadmap for Buildings and Construction Bangladesh

The Climate Action Roadmap for Buildings and Construction Bangladesh, published in October 2024, outlines a comprehensive strategy to address the pressing challenges of climate change within the buildings sector (Bangladesh, Ministry of Housing and Public Works 2024). By 2030, the country aims to achieve a 30 per cent reduction in embodied carbon and a 25 per cent reduction in operational carbon compared to 2020 levels. As the roadmap progresses towards 2040, these targets increase to a 60 per cent reduction in embodied carbon and a 50 per cent reduction in operational carbon. Ultimately, by 2050, Bangladesh aspires to reach near-zero embodied carbon in new constructions and near-zero operational carbon in both new and existing buildings.

The roadmap highlights the essential role of key stakeholders such as the Ministry of Housing and Public Works, the Dhaka Urban Development Authority and various research institutions such as the Housing and Buildings Research Institute, in implementing these ambitious goals. The key areas of focus include spatial and urban development, which aims to limit carbon emissions and create climate-sensitive cities. Moreover, the roadmap emphasizes reducing emissions from household energy, ensuring the transition to low-carbon materials, and improving resilience throughout the construction supply chain.

7.4.4 Climate Action Roadmap for Buildings and Construction in Senegal

Senegal's Climate Action Roadmap for Buildings and Construction, published in October 2024, aligns with the GlobalABC methodology and covers five pivotal action areas (Senegal, Ministry of Urban Planning, Territories and Regional Development 2024). The country commits to work towards achieving low-carbon buildings by 2050, prioritizing the use of sustainable materials, passive cooling, nature-based solutions, solar energy and circularity approaches, and strengthening the capacities of professionals in the buildings and construction sector. By 2040, the focus shifts to ensuring that professionals are well-informed about energy efficiency measures and the use of bio-sourced materials. The long-term vision aims for improved building quality through the integration of low-carbon materials by 2050.

Key stakeholders, including the Ministry of Urban Planning, Territories and Regional Development, are crucial for the successful implementation of this roadmap. A significant emphasis is placed on spatial and urban development, and advocating for the integration of nature-based solutions and solar technologies in building designs. The roadmap also addresses the need for energy-efficient practices in both new and existing buildings while promoting environmentally friendly construction methods throughout the supply chain.

7.5 Other roadmap developments for buildings and construction

In 2024, several significant roadmaps were developed and published by partners using other methodologies. These roadmaps make valuable contributions to global efforts aimed at advancing sustainable practices within the buildings and construction sector and provide critical insights and innovative strategies tailored to regional contexts.

The Canada Green Buildings Strategy, released in July 2024 by Natural Resources Canada, outlines a roadmap to decarbonize the sector by prioritizing emissions reduction, energy efficiency and resilience. Canada faces an ambitious challenge: at least 3.5 million new homes will be needed by 2030 and retrofit rates must accelerate to three per cent per year to achieve net zero emissions in the buildings sector by 2050. With over US$400 billion in capital investment needed over the next 30 years and job demand expected to rise significantly—45 per cent for HVAC tradespeople and 55 per cent for electricians by 2030—the strategy emphasizes partnerships and innovation to meet climate goals and drive sustainable economic growth.

Turkiye's 2023 Building Sector Decarbonization Roadmap outlines ambitious targets, including a 50 per cent reduction in operational carbon emissions by 2030 (Bayraktar *et al.* 2023). To achieve this, the roadmap sets out specific measures such as implementing stricter energy efficiency standards, scaling up renewable energy integration in buildings and promoting energy-efficient retrofits for existing structures. It also highlights the adoption of circular economy principles such as material reuse and waste reduction, alongside fostering interdisciplinary collaboration among policymakers, industry and academia. These coordinated efforts form a comprehensive strategy to meet the country's climate commitments while driving innovation and inclusivity in both new and existing buildings.academia. These coordinated efforts form a comprehensive strategy to meet the country's climate commitments while driving innovation and inclusivity in both new and existing buildings.

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Chapter 8 International policy initiatives to accelerate buildings decarbonization

The Breakthrough Agenda was launched during COP26 in Glasgow in 2021 (COP26 Presidency 2021) as a collaborative framework by countries to accelerate the net zero transition in highly emitting sectors of the economy. Initially the Agenda covered agriculture, power, hydrogen, steel and road transport. During COP28 in Dubai in 2023, the buildings sector joined the process with the launch of the Buildings Breakthrough Agenda (IEA *et al.* 2024). The Breakthrough Agenda process aims to foster international collaboration within each sector and to establish sector decarbonization goals that participating countries can endorse and support, and that enable equity and diversity. It is assumed that political endorsement will enable faster transition in the respective sectors. The process is anchored in the annual UNFCCC COP meetings and is supported by an annual progress report prepared by the IEA and the UN Climate Change High Level Champions (IEA *et al.* 2024). The purpose of the report is to track progress with respect to the agreed goals and to make recommendations to further international collaboration. The 2023 and 2024 editions of the report included chapters on the Buildings Breakthrough.

On the official launch date of 6 December 2023, under the co-leadership of France and the Morocco, the Buildings Breakthrough defined the near-term goal for the transition of the sector: "Near-zero emission and resilient buildings are the new normal by 2030". This goal has since been endorsed by 29 countries (with support from the European Commission) drawn from all world regions.

To actualize this near-term goal, a range of international organizations and their initiatives are supporting the framework, which provide guidance for actions to be taken by national governments. The Buildings and Climate Global Forum, which took place in March 2024 in Paris, saw the launch of first set of priority actions on B1) Standards and Certification, B2) Demand Creation, B3) Finance and Investment, B4) Research and Deployment, B5) Capacity and Skills, and B6) Landscape Coordination (GlobalABC *et al.* 2024). The initial review of these actions, as detailed in the *Breakthrough Agenda 2024 Report*, found moderate or minimal progress only. However, it is important to note that the short period between commitment to these actions and publication of the report left limited time for any initiatives or efforts by endorsing governments to make significant impact.

Nevertheless, the report does acknowledge that some progress has been made. An example is advancing common definitions for terms used to express standards and goals, such as a national definition for "zero emission building" presented by the United States of America Department of Energy (GlobalABC *et al.* 2024), or the definition of the term in the European Energy Performance of Buildings Directive (European Parliament 2024). These developments are noteworthy because agreement of common terminology in the sector is seen as a prerequisite for successful international collaboration. Progress has also been reported by several industry bodies in the alignment and harmonization of definitions and development of standards, including for Whole Life Carbon and Climate Resilience.

Table 5. The Buildings Breakthrough Agenda: Priority actions and recent progress

2025 priority international action (launched at COP29)	Objective	Progress/potential key COP30 deliverables
B1) Standards and Certification	Build consensus among countries on qualitative definitions and principles for Near-Zero Emissions and Resilient Buildings (NZERB) across the entire life cycle, and outline related indicators, as well as guidelines to help ensure transparency, comparability and accountability, and consult on these over 2025.	**Progress:** Consultation workshop on NZERB definition, gathering of existing work and efforts in the landscape, setting up of working group governance and 2025 work plan **COP30:** NZERB report, including guidelines and policy recommendations
B2) Demand Creation	Create procurement and policy commitments for NZERB, for both new buildings and deep renovation projects, and join relevant initiatives to aggregate these commitments, as well as favour alignment of procurement policies on NZERB-related standards for clean and efficient heating and cooling technologies.	**Progress:** Launch of Global Framework for Action outlining five core principles to achieve NZERB through Sustainable Public Procurements **COP30:** Finalizing of the Global Framework for Action and country implementation
B3) Finance and Investment	Support countries, in particular emerging markets and developing economies, to expand international financial and technical assistance programmes that address blended finance instruments, policies, capacity-building of local banks and lenders, as well as build a project pipeline and address data gaps.	**Progress:** Consultation workshop on financing NZERB and definition of activities under working group **COP30:** NZERB Finance Roadmap template and pilot country roadmap
B4) Research and Deployment	Coordinate with governments and companies to jointly identify research priorities and knowledge gaps, share research, development and demonstration priorities and leverage existing networks to gather expertise and additional country members; as well as drive solution deployment by identifying shared challenges, highlighting replicable models, and leveraging existing networks through a participative and collaborative effort with governments.	**Deployment objective:** **Progress**: Launch of Blueprint on Deployment Platform, with Solutions and Technologies for the buildings and construction sector **COP30:** Catalogue of Solutions and identification of pilot projects **Research objective:** **Not yet started**
B5) Capacity and Skills	Coordinate with countries and organizations to identify training and capacity-building priorities (including institutional capacities of national governments and local authorities), and leverage existing networks to share capacity-building resources and tools across all regions, with a focus on the establishment and compliance of building codes (in line with NZERB principles and requirements); and to include NZERB principles and practices in institutional capacity building, educational curricula, training programmes, competency assessments and accreditation frameworks.	**Progress:** Launch of Interim report on Institutional and Personnel Capacity to Deliver Near-Zero Emission and Resilient Buildings **COP30:** Report of the key institutional and personnel capacity-building needs for achieving NZERB and online portal
B6) Landscape Coordination	Enhance the coordination and transparency of international collaboration on near-zero emission and resilient buildings	Mapping of initiatives ongoing

The report recommends a range of further actions to advance the sector's net zero transition, including agreement between countries on definitions and principles for building standards, codes and public disclosure, collaboration on aligning key indicators and performance metrics, and agreement of data collection and standardization to support more effective reporting, monitoring and benchmarking of the sector's performance. Agreed milestones should serve as accelerators for the transition and elements of a de-risking strategy for investment in the sector.

International collaboration has gained momentum since the launch of the Buildings Breakthrough in December 2023. The French government hosted the first Buildings and Climate Global Forum in March 2024, bringing ministerial-level delegates from participating countries together with leaders from the private sector, academia and civil society. A total of over 1,400 delegates discussed solutions over the two-day event, resulting in a political outcome document, the Chaillot Declaration, which has been signed by over 60 governments. The declaration contains a list of actions addressed at state and non-state actors, and proposed a governance mechanism in the form of an Intergovernmental Council on Buildings and Climate. It explicitly acknowledges the link between climate action in the sector and a just transition, as evidenced by the diverse ministerial representation at the forum, which included delegates from housing, construction, energy and climate governmental bodies.

The signatories to the Chaillot Declaration have committed to align their actions on decarbonization and resilience in the buildings sector with the Paris Agreement. Agreed policies include the implementation of national regulatory frameworks, including the adoption of mandatory building and energy codes, leading by example through ambitious procurement policies, in particular for public buildings, promoting production and use of low-carbon and sustainably sourced construction materials, enhancing skills and capacity building across the sector and developing and enabling multi-level governance, stakeholder engagement and participative approaches (Building and Climate Forum 2024).

The Council consists of the signatories to the Chaillot Declaration and observers to the process and is the implementing body of the Declaration (UNEP and GlobalABC 2024). It is mandated to meet twice a year on a technical level and once a year on a ministerial level. The inaugural ministerial meeting was held during COP29 in Baku, Azerbaijan. It is currently co-chaired by a troika of France, Brazil and Kenya, and its work and meetings are to be facilitated by the GlobalABC Secretariat.

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Chapter 9 Conclusions: The challenges ahead

The Paris Agreement goals, which for the buildings sector means that all new buildings are to be zero carbon emission by 2030 and all buildings are zero-carbon emission by 2050 at the latest, are the benchmark against which to measure decarbonization progress of the sector. The 2024 GBCT reveals that the sector is well off track, and that immediate and bold action is required to reverse the trend and close the gap between the actual and desired decarbonization trajectory.

To support the buildings and construction sector to accelerate progress towards meeting a Paris-aligned pathway, the Global Status Report presents a set of challenges that different actors across the sector must address.

Improving energy efficiency is paramount, as the buildings sector accounts for a significant portion of global energy consumption and CO_2 emissions. The IEA currently estimates that the energy use intensity in the buildings sector needs to decrease by 37 per cent from 2015 levels by 2030. However, as of 2022, this key indicator of decarbonization progress was 15 per cent above target. Progress towards energy-efficient retrofits of existing buildings is another crucial indicator of progress, given that around 80 per cent of the current building stock will still be in use by 2050. Here too, the news is not encouraging, with a current retrofitting rate of about one per cent per year, against a required 5–10 per cent annually. The development and enforcement of robust policies and regulations are crucial for driving decarbonization efforts. Many countries have outdated building codes that do not align with net zero operational emissions goals. Establishing ambitious energy codes aligned with ZEB principles is necessary. Additionally, there is an important opportunity for countries to be ambitious in their next submission of the NDC 3.0 to clearly show how they are rising to the challenge.

Challenge 1: Implement effective and target-oriented building codes. Major carbon emitting countries, including the G20 and European Union, must adopt mandatory, modern zero-carbon building energy codes by 2028, earlier than the global goal. For all other countries that have established building energy codes, these must be upgraded to align with zero-carbon-ready building standards, and where voluntary made mandatory, by 2030. Meanwhile, all countries without building energy codes should set out a clear pathway to adopting mandatory codes as soon as feasible, but no later than 2035. Codes should be right-sized and enforceable in the jurisdiction in which they are adopted, and adoption should be coupled with capacity-building to ensure that the codes can be enforced and result in more resilient, lower-emitting buildings.

Challenge 2: Triple the rate of energy efficiency retrofits and upgrades of existing buildings by 2030 to shift the energy use intensity of buildings towards the goal of 96 kWh/m²/yr, which requires achieving a 35 per cent reduction in energy intensity from current levels. For major carbon-emitting countries this means acting to upgrade walls, windows and other passive designs, and adopting high-performance heating and cooling systems such as heat pumps. For emerging and developing economies, this means adopting a targeted approach to older buildings and introducing requirements for mandatory improvements to existing buildings in building energy codes and in other policies such as minimum performance standards.

The integration of renewable energy sources into buildings is essential. In 2022, direct renewable energy use generated from buildings accounted for only six per cent of buildings' final energy consumption, far short of the 19 per cent target set for 2030 under the Marrakesh

Partnership. Increasing this share requires substantial investment and policy support to facilitate the transition from fossil fuels to renewable sources.

> **Challenge 3:** Reflect the global goal of tripling renewable energy in buildings. Accelerate the deployment of renewables to increase the share of buildings' onsite generated renewable energy from six per cent to 19 per cent, and raise the total share of electricity consumed from renewable sources (on- and offsite) from 11 per cent to 46 per cent by 2030.

Anchoring buildings decarbonization policies through the global UNFCCC process is an important step to accelerate action and to provide inspiration and benchmarks for all countries. NDCs are an important tool to monitor the implementation of the Paris Agreement. They provide the framework for countries' actions to decarbonize every sector. However, to date the majority of NDCs lack detail on the buildings sector.

> **Challenge 4:** All major emitting and G20 governments must ensure that their NDC 3.0 submissions provide extensive coverage of the buildings sector, including details about the building code reform plans (as per NDC guidance). Biennial Update Reports should be used to track these efforts and ensure accountability, including an assessment of how effectively the codes are being implemented.

Embodied carbon emissions from building materials and construction processes remain a significant challenge. These emissions must be reduced through the adoption of sustainable materials and construction practices. This includes using materials with lower carbon footprints, promoting circular economy principles to minimize waste and designing for equivalent outcomes with less material use.

> **Challenge 5:** All major emitting and G20 countries should adopt embodied carbon emission limits within their building energy codes by 2030, supported by clear guidance on accounting and reporting frameworks. All other countries should reference and promote the use of low-carbon materials in their building energy codes, with compliance paths that prioritize building reuse and stretch targets for embodied carbon limits that meet or exceed regional best practice standards.

Financing remains a major hurdle, as investments in decarbonizing buildings have consistently fallen short of targets in recent years. Financial incentives such as subsidies, grants and green mortgages are needed to stimulate investment in energy efficiency and low-carbon technologies.

> **Challenge 6:** Double the rate of investment in energy efficiency in existing and new buildings from US$270 billion to US$522 by 2030. Major emitting economies need to leverage public financing while also incentivizing private sector investment to increase the flow of funds toward decarbonization of their buildings sector. Additionally, all governments should ensure that green financing and lending programmes incorporate mechanisms to fully account for the carbon costs and social value of investing in the decarbonization of buildings.

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References

Ades, D., Campbell, M., George, T., Holland, T., Matthews, C., Mitchell, J. *et al.* (2024). *Financing US Building Decarbonization: Leveraging a Sector-Wide Emissions Model to Prioritize Capital Flows*. RMI. https://rmi.org/insight/financing-building-decarbonization-leveraging-a-sector-wide-carbon-model-to-prioritize-capital-flows/.

Alliance HQE, Building Research Establishment, Green Building Council of Australia, Singapore Green Building Council and United States Green Building Council (2024). *Financing Transformation: A Guide to Green Building for Green Bonds and Green Loans*. https://www.usgbc.org/resources/financing-transformation-guide-green-building-green-bonds-and-green-loans.

American Institute of Architects California (2023). CALGreen Mandatory Measures for Embodied Carbon Reduction, 5 September. https://aiacalifornia.org/news/calgreen-mandatory-measures-for-embodied-carbon-reduction/.

Baker McKenzie (2024). Global Sustainable Buildings Guide. https://resourcehub.bakermckenzie.com/pl-pl/resources/global-sustainable-buildings.

Bangladesh, Ministry of Housing and Public Works (2024). *Climate Action Roadmaps for Buildings and Construction Bangladesh*. https://globalabc.org/sites/default/files/2024-10/Climate per cent20Action per cent20Roadmaps per cent20for per cent20Buildings per cent20and per cent20Construction per cent20Bangladesh_0.pdf.

Baniassadi, A., Heusinger, J., Gonzalez, P.I., Weber, S. and Samuelson, H.W. (2022). Co-benefits of energy efficiency in residential buildings. Energy 238, 121768. https://doi.org/10.1016/j.energy.2021.121768.

Bank for International Settlements (2024). Residential property prices. Dataset. https://data.bis.org/topics/RPP/BIS per cent2CWS_SPP per cent2C1.0/Q.5R.N.771?additional_ts=BIS per cent2CWS_SPP per cent2C1.0 per cent255EQ.4T per cent2BXM per cent2BJP per cent2BXW per cent2BUS per cent2BIN.N.771&view=chart&filter=TIMESPAN per cent3D2015-01-01_2024-11-09

Bayraktar, M., Binatli, B. and Üzümoglu, T. (2023). *Türkiye Building Sector Decarbonization Roadmap Extended Summary*. Zero Carbon Building Accelerator Project. https://wrisehirler.org/sites/default/files/Turkiye per cent20Building per cent20Sector per cent20Decarbonization per cent20Roadmap...pdf.

BlocPower (2024). BlocPower's Civilian Climate Corps. https://staging.blocpower.io/civilian-climate-corps.

Buildher (2024). Buildher. https://www.buildher.org.

Building and Climate Forum (2024). Declaration de Chaillot. https://www.ecologie.gouv.fr/sites/default/files/documents/declaration-de-chaillot-forum-batiments-climat.pdf

Canada Green Building Council (2024). Zero Carbon Building Standards. https://www.cagbc.org/our-work/certification/zero-carbon-building-standard/.

Campbell-Johnston, K., de Munck, M., Vermeulen, W. and Backes, C. (2021). Future perspectives on the role of extended producer responsibility within a circular economy: A Delphi study using the case of the Netherlands. Business Strategy and the Environment 30. https://doi.org/10.1002/bse.2856.

China (2023). The People's Republic of China Third Biennial Update Report on Climate Change. https://unfccc.int/sites/default/files/resource/China_BUR3_English.pdf.

Cities Climate Finance Leadership Alliance (2024a). *Financing Net Zero Carbon Buildings in Central Asia*. Cities Climate Finance Leadership Alliance.

Cities Climate Finance Leadership Alliance (2024b). *The State of Cities Climate Finance 2024*. Cities Climate Finance Leadership Alliance.

Climate Disclosure Project (2023). CDP's latest Cities A List. https://data.cdp.net/browse?sortBy=relevance&pageSize=20.

Commonwealth Association of Architects (2024). Survey of National Building Codes. https://issuu.com/comarchitect.org/docs/241129_caa_ksp_building_code_survey_final.

Construction21 (2024). Decarbonisation: Denmark's new buildings even less emissive from 2025, 12 June. https://www.construction21.org/articles/h/decarbonisation-denmark-s-new-buildings-even-less-emissive-from-2025.html.

COP26 Presidency (2021). The Breakthrough Agenda. https://webarchive.nationalarchives.gov.uk/ukgwa/20230311221206/https://ukcop26.org/cop26-world-leaders-summit-statement-on-the-breakthrough-agenda/.

d'Ambrosio Alfano, F.R., Bellia, L., Fragliasso, F., Palella, B.I. and Riccio, G. (2019). Hue-Heat Hypothesis: A Step forward for a Holistic Approach to IEQ. *E3S Web of Conferences* 111, 02038. https://doi.org/10.1051/e3sconf/201911102038.

District of Columbia Sustainable Energy Utility (2024). Affordable Housing Retrofit Accelerator. https://www.dcseu.com/affordable-housing-retrofit-accelerator.

Deloitte (2024). 2025 Engineering and construction industry outlook, 4 November. https://www2.deloitte.com/us/en/insights/industry/engineering-and-construction/engineering-and-construction-industry-outlook.html.

Delzendeh, E., Wu, S., Lee, A. and Zhou, Y. (2017). The impact of occupants' behaviours on building energy analysis: A research review. Renewable and Sustainable Energy Reviews 80, 1061–1071. https://doi.org/10.1016/j.rser.2017.05.264.

Dwivedi, S., Taushiba, A., Zehra, F., Gupta, S.K. and Lawrence, A. (2023). Revelations to indoor air pollutants and health risk assessment on women: A case study. Hygiene and Environmental Health Advances 5, 100038. https://doi.org/10.1016/j.heha.2022.100038.

Energiesprong UK (2023). Destination Zero - whole house retrofit for social housing providers. https://www.energiesprong.uk/projects/destination-zero-whole-house-retrofit-for-social-housing-providers.

Etzi, R. and Gallace, A. (2016). The arousing power of everyday materials: an analysis of the physiological and behavioral responses to visually and tactually presented textures. Experimental Brain Reseach 234, 1659–1666. https://doi.org/10.1007/s00221-016-4574-z.

European Commission (2020). A new Circular Economy Action Plan. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

European Commission (2024). Building materials: Council adopts law for clean and smart construction products. https://www.consilium.europa.eu/en/press/press-releases/2024/11/05/building-materials-council-adopts-law-for-clean-and-smart-construction-products/

European Council (2023). European Green Bonds: Council adopts new regulation to promote sustainable finance, 24 October. https://www.consilium.europa.eu/en/press/press-releases/2023/10/24/european-green-bonds-council-adopts-new-regulation-to-promote-sustainable-finance/.

European Environment Agency (2024). Addressing the environmental and climate footprint of buildings (No. EEA Report 09/2024). Copenhagen: European Environment Agency.

European Mortgage Federation (2024). Average mortgage interest rate in Europe in from 2021 to 2023, by country. https://www.statista.com/statistics/615037/mortgage-interest-rate-europe/.

European Parliament (2024). Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast), PE/102/2023/REV/1.

France, Le Conseil d'Etat (section des travaux publics) (2021). Décret n° 2021-1941 du 31 décembre 2021 relatif à la responsabilité élargie des producteurs pour les produits et les matériaux de construction du secteur du bâtiment.

France, Fédération française du bâtiment (2022). REP Bâtiment : vers une massification du recyclage des déchets. https://www.ffbatiment.fr/revues-guides/bam/69-decembre-2022/rep-batiment-vers-une-massification-du-recyclage-des-dechets.

France, Fédération française du bâtiment (2023). Déchets de chantier : c'est quoi la REP Bâtiment? https://www.ffbatiment.fr/revues-guides/bam/69-decembre-2022/rep-batiment-vers-une-massification-du-recyclage-des-dechets.

France, Institut Français pour la Performance du Bâtiment, Global Alliance for Buildings and Construction, ADEME and A4MT (2024). Sufficiency and the Built Environment: *Reducing Demand for Land, Floor Area, Materials and Energy as the First Step Towards Sustainable Buildings*. Paris: GlobalABC Sufficiency Hub. https://globalabc.org/resources/publications/sufficiency-and-built-environment.

France, Ministère de la Transition Écologique (2020). The Anti Waste Law in the Daily Lives of the French People: What does that mean in practice? https://www.ecologie.gouv.fr/sites/default/files/documents/en_DP per cent20PJL.pdf.

France, Ministère de la Transition Écologique (2023). Arrêté du 28 février 2023 modifiant le cahier des charges des éco-organismes de la filière à responsabilité élargie du producteur des produits et matériaux de construction du secteur du bâtiment annexé à l'arrêté ministériel du 10 juin 2022. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000047254455.

France, Ministère de la Transition Écologique (2024). Produits et matériaux de construction du secteur du bâtiment (PMCB). https://www.ecologie.gouv.fr/politiques-publiques/produits-materiaux-construction-du-secteur-du-batiment-pmcb.

G20 Presidency (2023). Voluntary Action Plan on Doubling the Global Rate of Energy Efficiency Improvement by 2030. https://www.seforall.org/system/files/2024-01/G20 per cent20ETWG per cent20PD per cent20- per cent20Voluntary per cent20AP per cent20on per cent20Doubling per cent20the per cent20Global per cent20Rate per cent20of per cent20EE per cent20Improvement per cent20by per cent202030_Annex per cent20B.pdf.

Germany (2020). Act on Energy Saving and the Use of Renewable Energies for Heat and Cooling in Buildings. https://www.gesetze-im-internet.de/geg/.

Germany, Federal Ministry for Economic Affairs and Climate Action (2024). New funding scheme for climate-friendly heating systems, 30 January. https://www.bmwk-energiewende.de/EWD/Redaktion/EN/Newsletter/2024/01/Meldung/topthema.html.

German International Cooperation Society (2024). Eficiencia Energética y Energías Renovables en Vivienda Existente. https://cooperacionclima.com.mx/proyecto/detalle?id=16.

Ghana, Ministry of Works and Housing (2024). Climate Action Roadmaps For Buildings and Construction Ghana. https://globalabc.org/sites/default/files/2024-11/Climate per cent20Action per cent20Roadmap_GHANA.pdf.

Gillingham, K.T., Huang, P., Buehler, C., Peccia, J. and Gentner, D.R. (2021). The climate and health benefits from intensive building energy efficiency improvements. *Science Advances 7*, eabg0947. https://doi.org/10.1126/sciadv.abg0947.

GIZ (2018). *Extended producer responsibility (EPR)* for managing packaging waste. Circular Economy Briefing Series. https://www.giz.de/en/downloads/giz2018_EPR-Packaging_web.pdf.

Global Alliance for Buildings and Construction (2024). *Climate Action Roadmaps for Buildings and Construction: Step-by-step guidance.* Nairobi.

Global Alliance for Buildings and Construction and Dubai Ministry of Energy and Infrastructure (2023). *GlobalABC Regional Roadmap for Buildings and Construction in the Arab Region*.

Global Alliance for Buildings and Construction and Local Governments for Sustainability (2021). *Climate Action Pathway: Human Settlements - Vision and Summary.*

Global Alliance for Buildings and Construction, de l'Urbanisme, de l'Habitat et de la Politique de la Ville, Ministère de la transition écologique et de la cohésion des territoires and United Nations Environment Programme (2024). Buildings Breakthrough Priority International Actions 2024.

Guida, G., Richter-Lunn, K. and Bechthold, M. (2024). Thermal-material priming: The influence of building materials on thermal perception and tolerance in immersive virtual environments. *Building and Environment* 266, 112073. https://doi.org/10.1016/j.buildenv.2024.112073.

Green Building Alliance (2024). Green Leasing. Processes. https://gba.org/resources/green-building-methods/processes/green-leasing/#:~:text=Green per cent20leases per cent20(also per cent20called per cent20aligned,products per cent2C per cent20or per cent20other per cent20sustainable per cent20actions.

Hidayetoglu, M.L., Yildirim, K. and Akalin, A. (2012). The effects of color and light on indoor wayfinding and the evaluation of the perceived environment. *Journal of Environmental Psychology* 32, 50–58. https://doi.org/10.1016/j.jenvp.2011.09.001.

Iceland (2024). Building regulations. https://www.byggingarreglugerd.is/?hluti=5#table-of-contents.

ICE Network (2024). Passive House in Akwesasne. https://www.icenet.work/c/case-studies/akwesasne-passive-house.

India, Ministry of Environment, Forests and Climate Change (2024). Solid waste management rules. https://moef.gov.in/orders/update.

International Code Council (2022). Global Building Resilience Guidelines. https://www.iccsafe.org/wp-content/uploads/22-21730_COMM_72922_Global_Resilience_Guidelines_FINAL_2.pdf.

International Code Council (2021). Leading the way to energy efficiency. https://www.iccsafe.org/products-and-services/iecc-on-a-mission/.

International Code Council (2024b). 2024 International Energy Conservation Code. https://codes.iccsafe.org/content/IECC2024P1.

International Energy Agency (2021). *Net Zero by 2050: A Roadmap for the Global Energy Sector*. Paris. https://www.iea.org/reports/net-zero-by-2050.

International Energy Agency (2023a). *Tracking Clean Energy Progress: Space Cooling*. https://www.iea.org/energy-system/buildings/space-cooling.

International Energy Agency (2023b). *Energy Efficiency 2023*. Paris. https://www.iea.org/reports/energy-efficiency-2023.

International Energy Agency (2023c.) *Global Energy and Climate Model: Documentation - 2023*. Paris. https://www.iea.org/reports/global-energy-and-climate-model.

International Energy Agency (2024a). W*orld Energy Outlook 2024*. Paris. https://www.iea.org/reports/world-energy-outlook-2024.

International Energy Agency (2024b). *Renewables 2023*. Paris. https://www.iea.org/reports/renewables-2023.

International Energy Agency (2024c). *Tracking Clean Energy Progress: Heat Pumps*. https://www.iea.org/energy-system/buildings/heat-pumps.

International Energy Agency and EEMR (2024d).E*nergy Efficiency 2024*. Paris https://www.iea.org/reports/energy-efficiency-2024.

International Energy Agency (2024e). *World Energy Investment 2024*. Paris. https://www.iea.org/reports/world-energy-investment-2024.

International Energy Agency (2024f). *COP28 Tripling Renewable Capacity Pledge: Tracking countries' ambitions and identifying policies to bridge the gap.* Paris. https://www.iea.org/reports/cop28-tripling-renewable-capacity-pledge.

International Energy Agency (2024g). Renewables 2024. Paris. https://www.iea.org/reports/renewables-2024.

International Energy Agency, International Renewable Energy Agency and United Nations Climate Change High-level Champions (2022). *The Breakthrough Agenda Report 2022: Accelerating Sector Transitions Through Stronger International Collaboration*. OECD. https://doi.org/10.1787/692cdb6b-en.

International Finance Corporation (2023). *Building Green: Sustainable Construction in Emerging Markets*. Washington, D.C. https://www.ifc.org/content/dam/ifc/doc/2023/building-green-sustainable-construction-in-emerging-markets.pdf.

International Finance Corporation and Amundi Asset Management (2024). *Emerging Market Green Bonds*. Washington, D.C. https://www.ifc.org/en/insights-reports/2024/emerging-market-green-bonds-2023.

Interreg (2023). Desirable, warm, affordable homes for life. https://vb.nweurope.eu/projects/project-search/mustbe0-multi-storey-building-e-0-refurbishment/.

JLL (2024). The green tipping point. https://www.jll.co.uk/en/trends-and- insights/research/the-green-tipping-point.

Kenya (2024). The National Building Code 2024, 47. 20 February. https://kenyalaw.org/kl/fileadmin/pdfdownloads/LegalNotices/2024/LN47_2024.pdf.

Laubinger, F., Brown, A., Dubois, M. and Börkey (2021). *Modulated fees for Extended Producer Responsibility schemes (EPR)*. No. OECD Environment Working Papers, No. 184. Paris : OECD Publishing. https://doi.org/10.1787/2a42f54b-en.

Lizon, T.G. (2023). Financiación de Ciudades Verdes en América Latina y el Caribe. División de Vivienda y Desarrollo Urbano (HUD) del Banco Interamericano de Desarrollo. https://blogs.iadb.org/ciudades-sostenibles/es/financiacion-de-ciudades-verdes-en-america-latina-y-el-caribe/.

Maidment, C.D., Jones, C.R., Webb, T.L., Hathway, E.A. and Gilbertson, J.M. (2014). The impact of household energy efficiency measures on health: A meta-analysis. *Energy Policy* 65, 583–593. https://doi.org/10.1016/j.enpol.2013.10.054.

Moloughney, B.W., Bursey, G.E., Fortin, R.B., Morais, M.G. and Dang, K.T. (2019). A Multicomponent Intervention to Encourage Stair Use in Municipal Buildings. *American Journal of Health Promotion* 33, 57–69. https://doi.org/10.1177/0890117118776893.

Macintyre, H.L. and Heaviside, C. (2019). Potential benefits of cool roofs in reducing heat related mortality during heatwaves in a European city. *Environment International* 127, 430–441. https://doi.org/10.1016/j.envint.2019.02.065.

MacNaughton, P., Cao, X., Buonocore, J., Cedeno-Laurent, J., Spengler, J., Bernstein, A. *et al.* (2018). Energy savings, emission reductions, and health co-benefits of the green building movement. *Journal of Exposure Science & Environmental Epidemiology* 28, 307–318. https://doi.org/10.1038/s41370-017-0014-9.

Mahila Housing Trust (2024). Mahila Housing Trust: Towards Responsible Urban Development. https://www.mahilahousingtrust.org.

New York City (2024). LL97 Greenhouse Gas Emissions Reduction.

National Australian Built Environment Rating System (2024). The Rules Embodied Carbon version 1.0. Sydney.

Nigeria, National Climate Change Council (2023). Nigeria's Long-term low-emission development strategy 2060.

Nigeria, National Climate Change Council (2024). Nigeria's Long-Term Low-Carbon Development Strategy. https://unfccc.int/documents/638193.

Okello, G., Devereux, G. and Semple, S. (2018). Women and girls in resource poor countries experience much greater exposure to household air pollutants than men: Results from Uganda and Ethiopia. Environment International 119, 429–437. https://doi.org/10.1016/j.envint.2018.07.002.

Organization for Economic Cooperation and Development (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. Paris: OECD Publishing.

Organization for Economic Cooperation and Development (2024a). Production of total construction. https://prosperitydata360.worldbank.org/en/indicator/OECD+MEI+PS+PRCNTO01.

Organization for Economic Cooperation and Development (2024b). *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach.* Paris: OECD Publishing. https://doi.org/10.1787/d662fdcb-en.

Palesch, N. (2024). Weakness in construction and its related sectors show the impact of interest rate hikes, 10 January. Oxford Economics. https://www.oxfordeconomics.com/resource/weakness-in-construction-and-its-related-sectors-show-the-impact-of-interest-rate-hikes/.

PassiveHouse (2024). Passive House Database: ID 7512.

Programme for Energy Efficiency in Buildings and GlobalABC (2024). *NDCs for Buildings: Ambitious, Investable, Actionable, and Inclusive*. Paris.

Petrichenko, K. and Vautrin, A. (2024). More efficient and flexible buildings are key to clean energy transitions, 4 April. International Energy Agency. https://www.iea.org/commentaries/more-efficient-and-flexible-buildings-are-key-to-clean-energy-transitions.

Prevent Waste Alliance (2020). EPR Toolbox. Factsheet 04. How can a register of obliged companies be established?. Bonn. https://prevent-waste.net/wp-content/uploads/2023/06/FS04_Register-of-obliged-companies.pdf.

Public Sector Global (2024). Lagos State Government to Introduce New Building Code in 2025, 13 December. https://publicsectormag.net/2024/12/13/lagos-state-government-to-introduce-new-building-code-in-2025/.

REN21 (2024a). *Renewables 2024 Global Status Report: Renewable in Energy Demand*. https://www.ren21.net/wp-content/uploads/2019/05/GSR2024_Demand_Full_Report.pdf.

REN21 (2024b). *Renewables Global Status Report*. https://www.ren21.net/gsr-2024/.

Research and Markets (2024). Europe Low-Carbon Construction Material Industry Research 2024: A $130.75+ Billion Market by 2032, Germany, France, and Netherlands Lead Adoption. https://www.globenewswire.com/news-release/2024/05/08/2877565/28124/en/Europe-Low-Carbon-Construction-Material-Industry-Research-2024-A-130-75-Billion-Market-by-2032-Germany-France-and-Netherlands-Lead-Adoption.html.

Rijkswaterstaat (2022). Kennisgeving van het algemeen verbindend verklaren van de Overeenkomst inzake de afvalbeheerbijdrage voor vlakglas, Ministerie van Infrastructuur en Waterstaat (No. 35215). Ministerie van Binnenlandse Zaken en Koninkrijksrelaties.

Rocky Mountain Institute (2024). 1,000 Apartment Challenge: REALIZE Massachusetts. https://rmi.org/our-work/buildings/realize/realize-ma/1000-apartment-challenge-realize-massachusetts/.

Royal Institution of Chartered Surveyors (2024). Global Construction Monitor, Q3 2024. London.

Sachdeva, A., Araujo, A. and Hirschnitz-Garbers, M. (2021). *Extended Producer Responsibility and Ecomodulation of Fees. Opportunity: Ecomodulation of Fees as a Way Forward for Waste Prevention*. Berlin: Ecologic Institute.

Samuelson, H., Claussnitzer, S., Goyal, A., Chen, Y. and Romo-Castillo, A. (2016). Parametric energy simulation in early design: High-rise residential buildings in urban contexts. *Building and Environment* 101, 19–31. https://doi.org/10.1016/j.buildenv.2016.02.018.

Senegal, Ministry of Urban Planning, Territories and Regional Development (2024). Feuille de route pour l'action climatique dans le secteur du bâtiment et de la construction au Sénégal. https://globalabc.org/sites/default/files/2024-10/Climate per cent20Action per cent20Roadmaps per cent20for per cent20Buildings per cent20and per cent20Construction per cent20Senegal.pdf.

South Africa (2008). National Energy Efficiency Strategy for South Africa. https://www.gov.za/sites/default/files/gcis_document/201409/32249580.pdf

South Africa (2023). https://www.gov.za/news/media-statements/treasury-publication-renewable-energy-incentives-2023-draft-taxation-laws.

South Africa (2023). SA Budget 2023: Solar panel tax incentive. https://www.sataxguide.co.za/sa-budget-2023-solar-panel-tax-incentive/.

South African Bureau of Standards (2011). Energy efficiency in buildings. https://store.sabs.co.za/sans-204-2011-ed-1-00-203544.html.

South African Bureau of Standards (2021). SANS 10400-XA:2021. https://store.sabs.co.za/catalog/product/view/id/2143705/s/sans-10400-xa-ed-2-00/.

Stechemesser, A., Koch, N., Mark, E., Dilger, E., Klösel, P., Menicacci, L. *et al.* (2024). Climate policies that achieved major emission reductions: Global evidence from two decades. Science 385, 884–892. https://doi.org/10.1126/science.adl6547.

Sun, K. and Hong, T. (2017). A framework for quantifying the impact of occupant behavior on energy savings of energy conservation measures. *Energy and Buildings* 146, 383–396. https://doi.org/10.1016/j.enbuild.2017.04.065.

Trisaputra Zuna, H. (2023). Indonesia Green Affordable Housing Program. https://thedocs.worldbank.org/en/doc/fff83f483c76eef814d7488b25689a10-0430012023/related/3-HerryTZ-DGIF-3rd-session-WB-Group-s-Global-Affordable-Housing-Conference-ed-250523-final.pdf.

Turner & Townsend (2024). International construction market survey 2024. https://publications.turnerandtownsend.com/international-construction-market-survey-2024/introduction.

United Kingdom Green Building Council (2024). Climate Change Mitigation. https://ukgbc.org/our-work/climate-change-mitigation/.

United Kingdom, Net Zero Buildings UK (2024). UK Net Zero Carbon Buildings Standard. https://www.nzcbuildings.co.uk/.

United Nations Environment Programme (2024a). *Emissions Gap Report 2024: No more hot air … please! With a massive gap between rhetoric and reality, countries draft new climate commitments*. Nairobi. https://doi.org/10.59117/20.500. 11822/46404.

United Nations Environment Programme (2024b). *Net-Zero Banking Alliance 2024 Progress Report*. Geneva: UNEP Finance Initiative.

United Nations Environment Programme, United Nations Development Programme and United Nations Framework Convention on Climate Change (2023). *Building Circularity into Nationally Determined Contributions (NDCs) – A Practical Toolbox: User Guide*. Nairobi. https://wedocs.unep.org/20.500.11822/43594.

United Nations Environment Programme and Yale Center for Ecosystems + Architecture (2023). *Building Materials and the Climate: Constructing a New Future*. https://wedocs.unep.org/20.500.11822/43293.

United States, Department of Energy (2024). Building Energy Code Program: State Portal. https://www.energycodes.gov/state-portal.

United States, International Trade Administration (2024). Vietnam Green Building Outlook, 29 August. https://www.trade.gov/market-intelligence/vietnam-green-building-outlook.

United States, The White House (2023). Federal-State Buy Clean Partnership Principles. Washington, D.C. https://www.sustainability.gov/pdfs/federal-state-partnership-principles.pdf.

Valobat (2022). Guide d'affichage et de répercussion de l'éco-contribution. https://www.valobat.fr/wp-content/uploads/2022/11/Guide-de-repercussion-de-leco-contribution-30.11.22.pdf.

Wastiels, L., Schifferstein, H.N.J., Heylighen, A. and Wouters, I. (2012). Red or rough, what makes materials warmer? *Materials & Design* 42, 441–449. https://doi.org/10.1016/j.matdes.2012.06.028.

World Green Building Council (2024a). Sustainable Building Certifications. https://worldgbc.org/sustainable-building-certifications/. Accessed 16 October 2024.

World Green Building Council (2024b). WorldGBC announces NDC Scorecard tool to strengthen national action on buildings, 17 October. https://worldgbc.org/article/worldgbc-announces-ndc-scorecard-tool/.

Yin, J., Zhu, S., MacNaughton, P., Allen, J.G. and Spengler, J.D. (2018). Physiological and cognitive performance of exposure to biophilic indoor environment. *Building and Environment* 132, 255–262. https://doi.org/10.1016/j.buildenv.2018.01.006.

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Annex Global Buildings Climate Tracker method

The first edition of the GBCT was released in 2020 as part of the *Global Status Report for Buildings and Construction* that year. This is its fourth edition. The GBCT is a composite index comprising seven indicators, described as a decarbonization index for buildings. The index monitors the progress towards the goal of totally decarbonizing the buildings sector by 2050.

The process to calculate the final index involves four steps: 1) data collection and processing, 2) normalization, 3) weighting and aggregation and 4) composite index calculation and analysis. The most recent available data allows analysing the decarbonization progress during the 2015–2023 period. During the normalization step, all the indicators are translated to a common scale by dividing the observations by the total range between their value at the starting point in 2015 and their goal value in 2050. Once the indicators are normalized, the CO_2 emissions indicator is used as a multiplier while the other six indicators are aggregated using a weighted sum. The weights, which were established in the first edition of the GBCT, are: impact indicators 37 per cent and action indicators 63 per cent. Then the final composite index is obtained and contrasted with the reference path towards the zero-carbon goal in 2050.

The Net Zero Emissions (NZE) scenario developed by the IEA (2023c) is used as the reference scenario to define the 2030 and 2050 goals for all the indicators. This scenario is consistent with limiting the global temperature rise to 1.5°C, in line with emissions reductions identified as necessary by the Intergovernmental Panel on Climate Change (IPCC) in its 2018 Special Report on Global Warming of 1.5°C. Specifically, it corresponds to scenarios that achieve net zero CO_2 emissions globally around 2050 and require substantial reductions by 2030, as assessed in the report. The goals for all the indicators, including 2030 milestones, are summarized in Table 6.

Table 6. GBCT indicators goals

Indicator	2030 milestone	2050 final goal
Emissions		
Buildings sector energy related emissions ($GtCO_2$/year)	4.4	0
Impact		
Buildings sector energy unit intensity (kWh/m²)	96.2	55.8
Renewable share in final energy demand in buildings (per cent)*	46.4	84.4
Action		
Cumulative energy efficiency investment in buildings (US$billion)	5,593.9	28,374.8
Green building certification (cumulative growth)	33.9	96.5
NDC considering buildings extensively (per cent aggregated)	75	100
Building codes ZEB-aligned (per cent aggregated)	75	100

Note: While the GBCT currently focuses on CO_2 emissions from building operations, it is important to consider the role of embodied carbon emissions in the buildings sector. However, these emissions are not included in the GBCT due to the absence of a global dataset covering a complete scope of embodied carbon emissions during the full time span of the tracker.

* The methodology and goal for the renewable share in final energy demand in buildings were updated in this edition. For more details, see the "Adjustments to indicators" section in this Annex.

The NZE scenario considers that CO_2 emissions from the operation of buildings reduce from the current levels to reach 4.4 $GtCO_2$/year by 2030 and 0 $GtCO_2$/year by 2050, while the energy intensity in buildings needs to reduce to 96.2 kWh/m² by 2030, and to 55.8 kWh/m² by 2050.

The energy efficiency investments in buildings indicator tracks cumulative investments starting from 2015. Based on the NZE scenario, annual investments in 2030 alone should grow to US$537.7 billion, leading to a cumulative total of US$5.6 trillion by 2030. After this, investments are projected to continue growing at a similar rate, reaching the 2050 goal of a cumulative total of US$28.4 trillion.

The cumulative growth of green building certification indicator is calculated based on the growth of the global building floor area. The building floor area certified as green is expected to grow (starting in 2015) 34 per cent by 2030, and 96.5 per cent by 2050. Hence, it is considered that the cumulative growth of building certifications should reach 33.9 points by 2030, and 96.5 points by 2050.

The indicator monitoring the number of countries with NDCs addressing the buildings sector in detail tracks the number of countries that have extensive coverage of buildings, including energy efficiency, adaptation, renewables and different forms of regulations and other building-related targets. The goal is for all G20 members and 50 per cent of other countries to include a detailed strategy for buildings in their NDCs by 2030, and for all countries to have done the same by 2050.

For the indicator tracking countries with building energy codes with ZEB principles, it is expected that, by 2030, all new buildings are zero emission buildings. All G20 members and 50 per cent of other countries are, furthermore, required to have ZEB-aligned building energy codes by this date. By 2050, all countries are expected to have these codes in place.

Adjustments to indicators

Only the indicator for renewable share in final energy demand in buildings experienced adjustments in this edition of the report. The methodology for this indicator was refined to include not only renewable energy directly used in buildings but also an estimation of the proportion of grid-supplied electricity derived from renewable sources. The share of electricity in final demand in buildings is combined with the share of renewable energies in electricity generation to estimate the portion of indirect renewable energies supplying the electricity provided to buildings. For instance, in 2023, the share of electricity in buildings' final energy demand in buildings was 37.4 per cent, while the contribution of renewables to grid electricity generation was 30.2 per cent, resulting, therefore, in a share of indirect renewable electricity in buildings of 11.3 per cent (37.4 per cent*30.2 per cent).

The goal was adjusted accordingly, adding the share of renewables directly used in buildings and the share of grid-supplied renewable electricity. The NZE scenario expects that the share of renewable energy directly used in the buildings sector increases to 18.1 per cent by 2030 and reaches 25 per cent by 2050. Furthermore, the scenario requires that, by 2030, 47.2 per cent of buildings' final energy demand is supplied by electricity, reaching 66 per cent by 2050. These percentages are applied to the scenario projection that around 60 per cent of grid electricity in 2030 will be generated by renewable energy sources, resulting in a 28.3 per cent (47.2 per cent*60 per cent) share of indirect renewable electricity in buildings by 2030. For 2050, the scenario projects that 90 per cent of grid electricity will be generated by renewable energy sources, leading to a 59.4 per cent (66 per cent*90 per cent) share of indirect renewable electricity in buildings by 2050. The combined goals correspond therefore to 46.4 per cent (18.1 per cent renewable directly use in buildings + 28.3 per cent renewable indirectly use in buildings) and 84.4 per cent (25 per cent renewable directly use in buildings + 59.4 per cent renewable indirectly use in buildings), respectively for 2030 and 2050.

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